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Repair Parts

THE user of power-plant apparatus, as of many other things, often feels aggrieved at the price that he is compelled to pay for apparently simple and inexpensive parts for repair and renewal.

With his mechanical sense and shop experience he realizes that such prices are far above cost of production even in limited quantities.

But the cost of production is not all, and the price is not the whole story.

The piece is part of an invention, probably patented. Into its design, proportions and material may have gone a lot of study, research and costly experience.

This initial and developmental expense cannot be absorbed by the first few sales, but must be spread out over a considerable output. The cost for material and labor is only a part, often a small part, of that of keeping such supplies readily available to the user.

In addition to the shop overhead there is the investment tied up in a large and widely distributed stock of such fractional products. Then there is the cost of packing, handling, transporting, bookkeeping and merchandizing.

It would cost considerable to deliver instantly on demand and be always prepared to do so, a fitting the cost of the labor and material in which is very small.

Of course, if one has the tools and knows how to use them, one can make the repair parts oneself or get them made at a local machine shop.

But this puts one out of relation with the service department, diverts the interest of the manufacturer and offers him an excuse for evasion of responsibility if he wants to avail himself of it.

The furnishing of repair parts and the keeping of his apparatus in satisfactory operation is part of the service that the quality producer delights in emphasizing as incidental to his product.

The wise manufacturer will desist from exploiting his customers and have a pride in showing low maintenance costs for his apparatus.

And the wise and appreciative user will be willing to pay a self-supporting charge for this service and like to feel that he had behind his purchase a service department keenly interested in keeping up its record for efficiency and effective, economical operation.

F. R. Low

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

Confidence and Prosperity

PRESIDENT-ELECT HOOVER'S plan of creating a fund for relieving unemployment and stabilizing industry in periods of depression, as presented by Governor Brewster of Maine to the recent conference of governors held in New Orleans, has many possibilities to recommend it to the consideration of those interested in the well-being of this country. In fact, it is of significance to all nations and has already attracted attention on the other side of the Atlantic.

In the final analysis industry must do the larger share of the stabilizing. If there are indications of an industrial depression on the business horizon, it will do little good for the government to attempt to avert the difficulty by increasing its expenditures for public works if business curtails its outlay faster than the government's increases. It is an all too common practice to make plant improvements only when business is good and to retrench on these expenditures in times of depression. This practice might well be reversed. In time of prosperity a fund should be created with which to make improvements during slack periods. This would insure the plant's having its highest efficiency in periods of greatest production.

The power industry, during the business depression that followed the World War, retrenched its building program only to experience a severe shortage of capacity when industry began to return to normal. A program of expansion instead of retrenchment would not only have helped to return industry to normal, but would have put the power companies in a better position to meet the demands placed upon them.

More accurate information on consumption and production would do much to assist in stabilizing industry. If some machinery could be set up whereby production could be adjusted to consumption, the peaks and valleys of business could be largely eliminated. However, this is not the whole answer to the problem, as there are many influences that must be counteracted by other means.

Prosperity is built in no small part on confidence. Confidence by the workers that if they spend a dollar, they will have the opportunity to earn another; confidence by industry that there will be a market for those things that it produces. When the workers lose confidence in the security of their jobs and industry in its market and a retrenchment of buying sets in, all the elements for a business depression have been established. A system whereby national, state and municipal governments would attempt to assist in stabilizing industry in periods of threatened depression could do much to maintain that confidence essential to prosperity.

Bars Specialization

IN HIS recent inaugural address, Dr. Harvey N. Davis, new president of Stevens Institute of Technology, declared emphatically for one fundamental unspecialized curriculum in engineering—a curriculum which embodies mathematics, physics, chemistry, mechanics, thermodynamics, electrodynamics and a background of academic studies calculated to develop the purely human side of an engineer's life.

No attempt will be made to teach the details of any branch of engineering. Instead, the aim will be to turn out young men who are well prepared *to begin to learn* the details of any one of many branches. To quote Doctor Davis, "They won't know much, but will have the saving grace of knowing that they don't know much, and of knowing what to do about it."

It is gratifying that Stevens Institute, one of the pioneer technical schools in this country, is to align itself with this progressive thought in engineering teaching. Although the idea that a technical school can turn out a finished product has long been exploded, many institutions still cling to a multiplicity of specialized courses. Happily they are, one by one, coming around to the broader view of the problem.

Opportunity plays such a large part in starting the graduate on his career, that specialization often proves a handicap. Moreover, in any branch of the field, progress is so swift that it would be impossible for a school so to adjust its courses as to keep up with practice. Specialization can best be acquired in the field, and the most that can be done by the school is to train the student to think and give him the groundwork for subsequent specialization. It is such training that gives the engineering graduate, other qualities being equal, an advantage over the non-technically trained man.

The Berlin Conference and the Dollar Sign

BY STRESSING the dollar sign more than technique, the Second Plenary Session of the World Power Conference (Berlin, 1930) will perform an outstanding service to engineering and to industry. Engineers need such reminders. They are ready on all occasions to admit that "engineering" which does not justify itself in dollars and cents is unworthy of the name. But their actions frequently belie their words.

This inconsistency is not hard to understand if one looks at the motives and impulses that guide men in their work. The average engineer is such because he has a

natural fondness for things mechanical. He likes to exercise his native ingenuity in the design, construction, installation and operation of machines. He is, in the broader sense, an artist who finds his greatest pleasure in the creative manipulation of materials and natural forces. Sometimes he finishes his formal education and is well started in practical work before he wakes with a shock to the fact that, whatever the urge that keeps him to his task, there would be no job for him if his talents could not be translated into profits.

Yet even the best of engineers, those who see most clearly the ultimate objective of their work, are in constant danger of slipping back into the attitude of technique for technique's sake.

It is therefore a hopeful sign that the Berlin conference, as recently announced by Herr F. zur Nedden and reported in the November 20 issue of *Power*, will insist on the economic point of view in every technical paper presented. High pressures, low-temperature carbonization, power storage and many other technical developments will be studied, but none of them will be allowed to become a fetish. Each must answer that greatest question of all, "What of it?"

Better Use of Byproduct Heat and Power

DESCRIPTION, elsewhere in this and the previous issue, of the comprehensive rehabilitation program carried out at the plant of the Packard Motor Car Company points to the possibilities of byproduct power recovery and heat balance in an industrial plant where antiquated and incapable equipment may be replaced by modern and properly applied apparatus. Records of this specific work show that such rehabilitation can be accomplished without interrupting the production in the factory, and that by making every step, as it comes into play, contribute to the increasing net return, the owner will enjoy a return on his investment comparable to that obtainable in the more direct elements of his business.

Reference to the articles cited will show that this specific work involved the replacement, while maintaining service, of a large number of small obsolete boilers by a modern boiler plant under automatic control; the gradual introduction of alternating-current motive power in the factory; the shutting down of engine-driven direct-current units through the installation of a turbine that will generate power only to the extent that it is available as a byproduct from heating and process steam, and the use of purchased current. Bled steam from the turbine goes to process, and the condenser of the turbine is used as a heater for a forced-circulation hot-water heating system serving the works. Maintaining a vacuum corresponding to the temperature of water required in the heating system permits increased byproduct power recovery over the usual method of utilizing exhaust steam at or near atmospheric pressure.

A more flexible arrangement, to provide process and heating steam with high byproduct power recovery, coupled with centralized control of all services from the power plant, scarcely could be imagined. Utilization of all available heat from the coal assures the highest economy obtainable. An absolute balance is maintained automatically between heating, process and a portion of the power load, while the remainder of the power is purchased at a favorable rate.

In the Packard rehabilitation every step in the program, after undergoing a careful analysis as to engineering feasibility, was set up as an economic proposition balancing the actual loads against the actual demands. Taking the earning power of the improvement as the difference between the gross savings and the fixed charges on the capital investment, each element of the complete plan has been reported to show a net revenue averaging 30 per cent, besides contributing to the increased capability of the plant to meet the growing demands.

Savings effected per year, running well up into the thousands, show that the power department, often but erroneously considered a minor factor in the manufacturing establishment, is worthy of serious investigation. When properly engineered, co-ordinated improvements will pay big returns on the investment, and the inclusion of flexible stand-by service may prevent a shutdown in production that easily could amount to more than the total investment involved.

Power and Production Can Pool Ideas

POWER and production are the prime activities of any industrial plant. Each job is big enough to take the whole time of a first-class engineering executive. Each must be the major or sole responsibility of one man. Yet no industry can achieve the finest results when the power engineer and the production superintendent struggle along in watertight compartments. Their work touches at a thousand points. Each must understand the other's problems to some extent if the whole productive organism is to function as a single smooth working machine to produce the best possible product at the lowest cost.

These men should work together in two distinct ways: First, each should think of his own problems in terms of those of the other man. The production superintendent should not install a large steam-consuming or power-consuming unit without consulting the power man on the available supply. Nor should the power engineer plan major changes in generating or transmission equipment without first getting the most dependable slant on the trend of productive activities.

This, perhaps, is obvious. Less obvious is the desirability of making full use of available talent. There are times when the power man should be called in on strictly production problems and vice versa. Who, for example, is better qualified than the power engineer to scrutinize heat losses from steam-jacketed kettles? Certainly the production man, in turn, can often give the power engineer pointers on cost keeping and similar matters.

Centralized Services from

Packard Power Plant

By R. J. Gaudy

Executive Engineer, Sessions Engineering Company

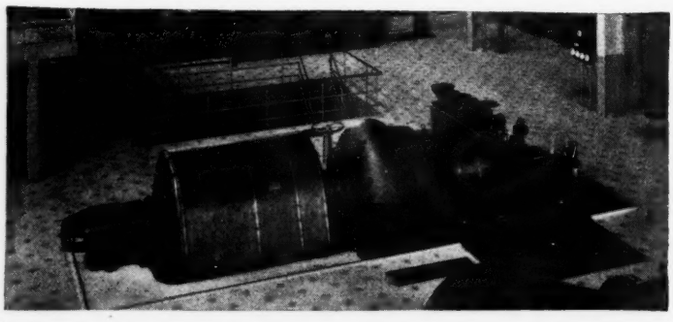
IN THE Nov. 27 issue an outline was given of the rehabilitation program carried out with the power and steam services of the Packard Motor Car Company. It will be recalled that the plan involved new boilers operating at 325 lb., a condensing turbine unit operating on the vacuum governed by the temperature of the water in a forced-circulation hot-water heating system, steam bled from the turbine at 85 lb. for process and steam generated from raw water in an evaporator installation for the hammers. The present article goes into more detail and gives a summary of the performance.

TO THE four new 12,000-sq.ft. water-tube boilers installed as part of the rehabilitation program, coal supplied from an overhead bunker is weighed through a weigh larry and introduced into the hoppers of ten-retort underfeed stokers. Above the stoker line the front and sides of each furnace carry a section of carborundum air-cooled wall. The full refractory walls above this point have given excellent service even at high ratings. A water wall at the back forms an integral part of the boiler. The boilers themselves, other than the addition of this forged-steel element, are of the standard four-drum type, fitted with feed-water regulators, steam purifiers and air preheaters of the cellular rotary type. The preheaters have both forced- and induced-draft fans.

Combustion Air Preheated to 400 Deg. F.

The forced-draft fan on the preheater forces the air into the windbox below the stoker at a pressure of 1.6 in., consistent with maintaining the overfire draft at 0.08 in. and overcoming the fuel-bed resistance. Before passing to the windbox, this combustion air is preheated to between 300 and 400 deg. F.

The superheaters are of the gill ring type located behind the front tube bank. The soot blowers are served with steam at boiler pressure. The high-pressure steam and water lines and much of the auxiliary piping have been erected consistent with the best welding and Van Stoning methods. There have been provided two manifold headers, one for each pair of boilers, that are tied together with a header loop. From the end of one of these headers the high-pressure line to the utility tunnel and thence to the forge shop, originates.



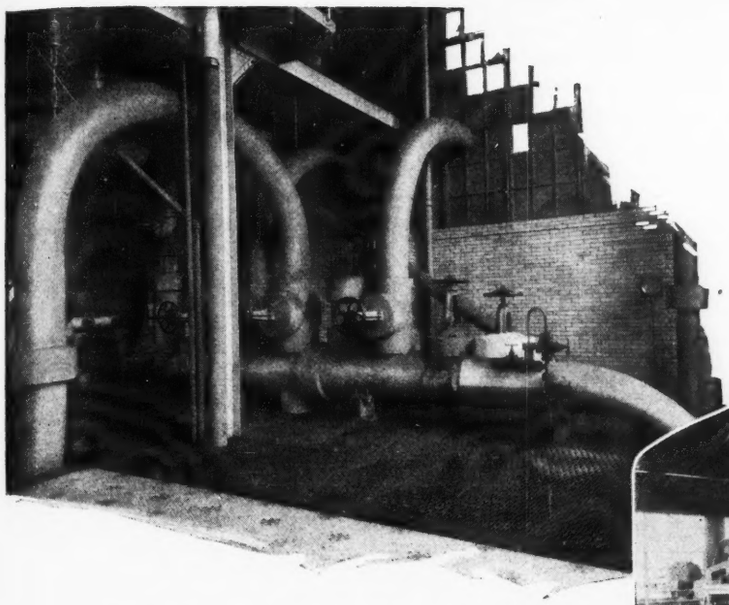
New 6,000-kw. turbine unit bleeding steam at 85 lb. for process and exhausting to condenser that is the heater for hot-water heating system

The evaporators, it will be recalled, function as two-effect in delivering low-pressure vapor to the feed-water system and as single-effect in delivering 85-lb. process steam from 150- or 325-lb. header steam. They are connected also so that they may serve as a tie between headers, introducing clean vapor to the system, in lieu of raw water with which they are supplied and which represents the makeup.

A complete system of boiler control is located on the control board. Boiler performance is recorded on a complement of multi-pen meters, giving records of quantities and temperatures relating to steam and air, and indicated and accumulated records of CO and CO_2. Supervisory control for all four boilers as to load division is located on a master control panel at the center of the control board, and the indications of draft are given for each boiler on a multiple-unit draft gage. On this board the throw-over of the entire boiler control from automatic to manual is possible, and the subsequent manual regulation of the fan and stoker motors is effected from the control room and the boiler fronts.

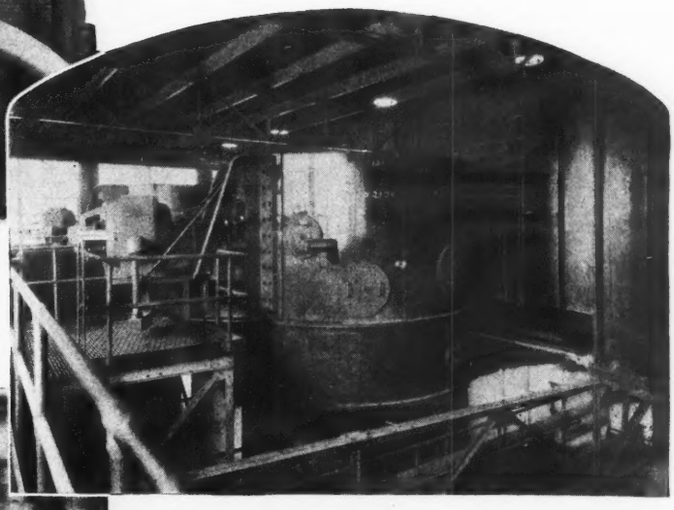
To preserve continuity of service, it was necessary to remove the original boilers in groups of two or three, taking out only enough at one time to accommodate one of the new boilers. The new ash-track level is far below the original lower level. Therefore, the building columns and footing walls had to be extended and underpinned and carried down to the new low level. The building structural steel was reinforced and shored in such a way that the coal bunker was preserved in its original po-

HERE AND THERE
in the Packard Plant

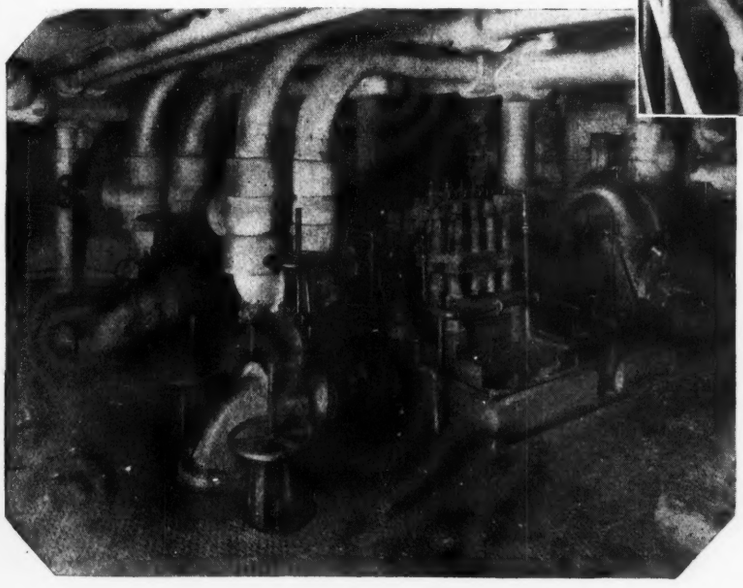


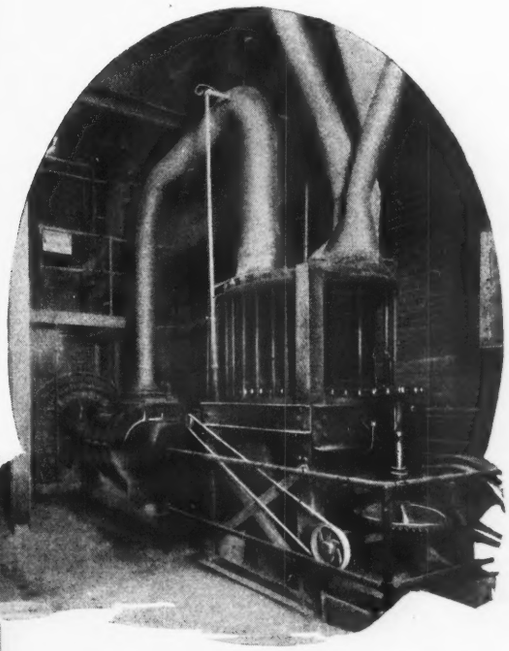
Above—Steam manifold in engine room

Below—Turbine-driven boiler-feed pumps

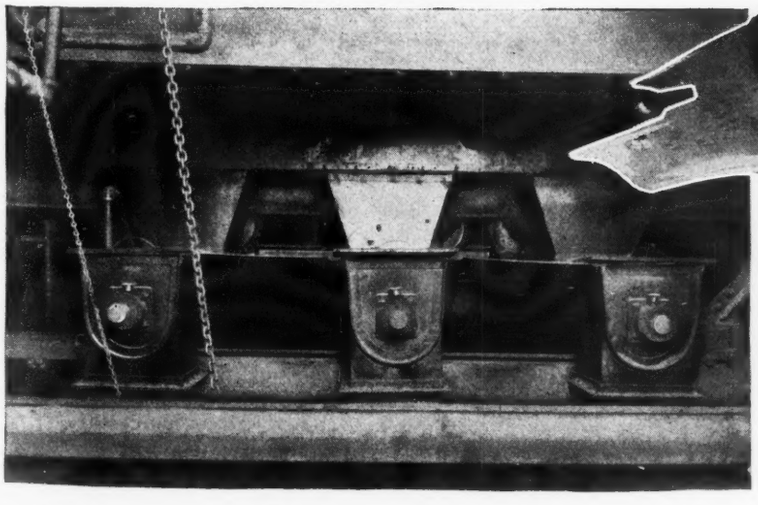


Above—One of the cellular rotary-type air preheaters





Above—Synchronous-motor-driven blower and sawdust charging set

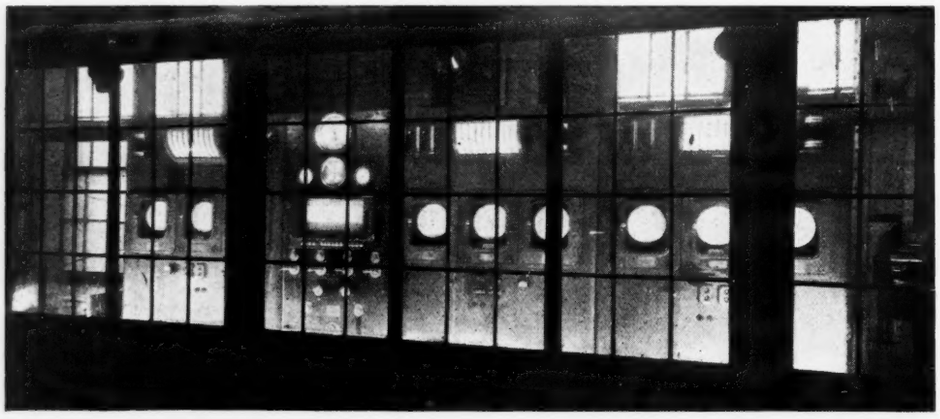


Left—Screw conveyor stokers over sawdust-burning furnaces

sition and the framing tied in with the subsequent new boiler framing.

Main supporting columns for the boilers were placed on foundations built at the lower level, and these columns were carried straight through to tie to the original steelwork and with detailed framing to accommodate the following features: The boiler with its setting; the preheater with its ducts and operating levels; the breeching, the bunker load on the boiler front and the framing for the penthouse to accommodate the preheater. The new arrangement of the operating-floor openings completely eliminated the old floor framing, and this level was re-established with new framing after the boiler structural work was in place.

Among the construction accessories to the boiler plant, not previously identified as parts of the equipment, should be mentioned the ash skip hoist, which delivers



Boiler-room control board in glass-inclosed room

the dry ash to an outside concrete storage tank from which it is either loaded on cars or removed by truck on contract. A more elaborate ash-handling system was eliminated by an analysis of the economics of the problem, as a minimum amount of labor handles the ash from the boiler ash hoppers to dump cars, wheels these dump cars to the boot of the skip hoist and, with no additional attendance, delivers the ash to the gravity tank outside.

It may be of interest to point out that the intake on the forced-draft side of the preheater is open to the boiler-room penthouse rather than outdoors. All that heat represented by the boiler radiation losses is passed through the preheaters and contributes to the resulting temperature. Makeup air is drawn in on the operating level by infiltration and normal ventilation, so that the working conditions around these boilers are much more satisfactory than would be true were the heat losses accumulated in a closed boiler room.

Burning Wood Refuse

Two of the original vertical boilers were retained for the burning of wood refuse. These are set with dutch ovens carrying inclined arches to burn the combined rubbish received and, owing to the nature of the fuel, are fitted with air-cooled side walls to conserve the furnace refractories.

Cuttings and rubbish from the wood mill are accumulated on a self-clearing pneumatic system and blown through a high-pressure blowpipe system of spiral piping to collectors and storage vaults at the main boiler house. The heavy material in this wood-mill rubbish and the wood refuse, including crating, scrap lumber and all sorts of combustible rubbish, are ground up in hogs. One of these hogs is installed at the salvage station built near the power house and the other at the wood mill, so that the high-pressure line also may transmit this prepared material. Both of these hogs are driven by synchronous motors, and the material removed from their discharge by suction fans is introduced into the blower system or storage.

Above each of the two boilers now set for wood firing is a refuse stoker, which by means of screw feed and engine drive, automatically supplies the wood refuse to the combustion chamber.

Generating Byproduct Power

The turbine-generator here illustrated is a 6,000-kw., 3,600-r.p.m. machine carrying its own exciter. The turbine is arranged with a double admission throttle, taking steam at both 325 lb. and 150 lb. and simultaneously bleeding at 85 lb. and exhausting to the condenser.

As the program progressed, the available 325-lb. steam increased in quantity as the new boilers were put into operation and the removed boilers brought about a proportionate decrease in the 150-lb. steam. As the plan is completed, the 150-lb. steam will be limited to that from the refuse-fired boilers and will be utilized for auxiliary drive and process steam supply, to the end that the turbine will be governing only on the high-pressure steam admission.

Installation of this turbine introduced a structural problem similar to that encountered in the boiler room. The old engine foundation ran to the present floor level. To accommodate the turbine with its condenser and the hotwell pit below, required that after the engine was removed, a section of the turbine room had to be excavated, including the engine foundation, and carried to a new low level. At this low point the footings for the turbine foundation were installed and a foundation of structural steel was erected to accommodate the condenser and carry the turbine to the original engine room floor level.

Carried on the substructure of the foundation, the condenser is placed at right angles to the line of the turbine shaft. The head of the condenser projects toward the well hole alongside the turbine, so that ample room for pulling the tubes is provided. This condenser, with its dry jets and hotwell pumps, was designed to function as a full vacuum condenser and at the same time as a water heater in which the discharge circulating water will run up to approximately 200 deg.

Cooling Tower as a Balancer

In the balance of the program which will be carried out to complete the project, there is involved a cooling tower that is unusual in that it will operate in connection with the forced-circulation hot-water heating system and discharge its water as a portion of the condenser water into a system having a higher hydrostatic head than the basin of the tower.

This cooling tower is not installed as an item of prime power generation, as the economy could not be justified if the investment in boiler capacity and turbine installation were not carried by other than cooling-tower generation. With the turbine in operation, however, the additional power to regulate the demand at a predetermined schedule is only a matter of admission of steam to the turbine and charging that steam cost plus the fixed charges of the cooling tower.

This step has been made necessary by the wide range within which the daily temperatures for any month vary in reference to the average. If, in a particular month, it is scheduled that 5,000 kw. will be carried on the turbine, then the allocation of the load between the turbine and the public utility is rather precise, as with uniform production the daily power demand and consumption recurs almost identically. During a cold month, for which the average would indicate that the heating system would absorb enough energy to justify a 5,000-kw. block of demand, a warm day will occur, during which it is necessary to waste some of the heat either by forcing it to the factory or by using some other method of dissipation, if the agreed electrical demand is to be sustained. It is at such a time that the cooling tower is called upon for service. During the heating system of 1927-28 the tower was not in operation, but has been erected at this time and connected into the existing water system.

Centralized Electric Distribution

As indicated previously, there were throughout the factory a series of transformer stations near load centers, which, prior to the completion of the power house had been transforming the public utility's service from 4,600 volts to 460 for general power, and 230-115 for lighting. The primary lines have been changed so that all the entering utility feeders, together with the turbine bus, which is on a throw-over bus with the spare lines, are concentrated at one primary installation on a gallery in the main power-house engine room.

Panels of this switchboard are of the truck type, with the double bus housing and complete arrangement of incoming and outgoing feeders accommodated in cubicles. In a complete underground system, constructed by the owner, radiating feeders run to the individual substations at the load centers. With this arrangement, supervision of continuity of service on the electric supply is now located, together with the steam and other services, at one central point of dispatch.

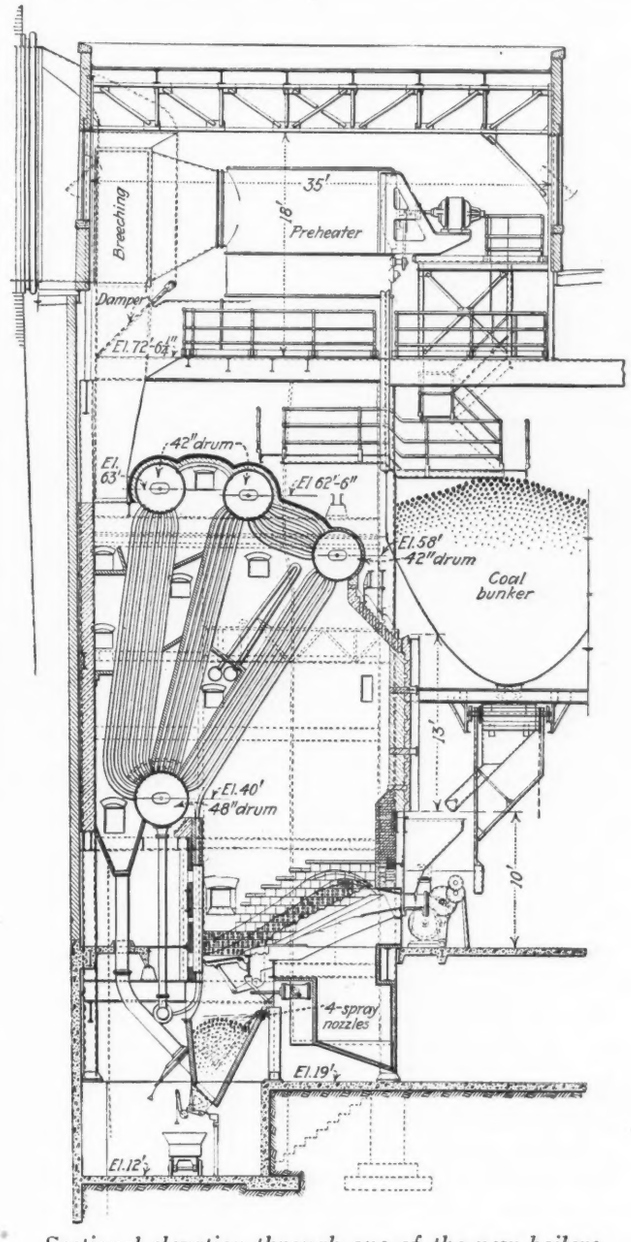
Accomplishments and Performance Summarized

The engineering of a rehabilitation program of this kind in the simplest sort of reconstruction plan would be much involved, but there were several objectives to be accomplished as the individual steps were carried forward. The land value and the central location of the plant indicated against any attempt to establish a new center at which a power plant could be built. Increasingly effective production methods continually increased the density of load to be served in the manufacturing area. The original plant capacity, as a steam generating plant, was rapidly being overtaken to a point where the demand was in excess of that which could be met by the usual type of equipment installed. The service of supply, including power, steam, heating, compressed air and all similar accessories to manufacture, must be maintained constantly and adequately.

The Sessions Engineering Company, of Chicago, undertook to bring about all these elements and to do the design and supervise the construction of the steps to carry out the program. Summarizing, the accomplishments of this program are as follows:

The heating system has been completely reconstructed with attendant marked increases in efficiency and reduced costs, saving 30 per cent of the heat delivered.

The boiler plant has been converted to a high-efficiency modernized boiler plant showing direct expense with



Sectional elevation through one of the new boilers

$4.25 coal of less than 26c. per thousand pounds of steam.

Heating has been supplied through a modern by-product turbine installation, which has derived the maximum revenue from the production of generated steam to useful value, generating 4,000 to 6,000 kw. continuously.

Extravagance in the use of back-pressure equipment exhausting to atmosphere has been eliminated, with its attendant elimination of makeup water and conservation of steam, system losses now being less than 15 per cent.

An isolated rubbish burning plant has been shut down and all the energy represented by mill waste and rubbish

has been recovered effectively and placed at the point of central control, producing from 700,000 to 900,000 lb. of steam per day.

A large isolated forge-plant boiler house has been shut down and this load, which varies from 40,000 to 80,000 lb. per hour, added for central generation to the block of load for all other purposes, to the end that high boiler ratings are possible, and by reason of the introduction of the evaporator at the forge plant, the matter of hammer exhaust loss is segregated from boiler-feed water control.

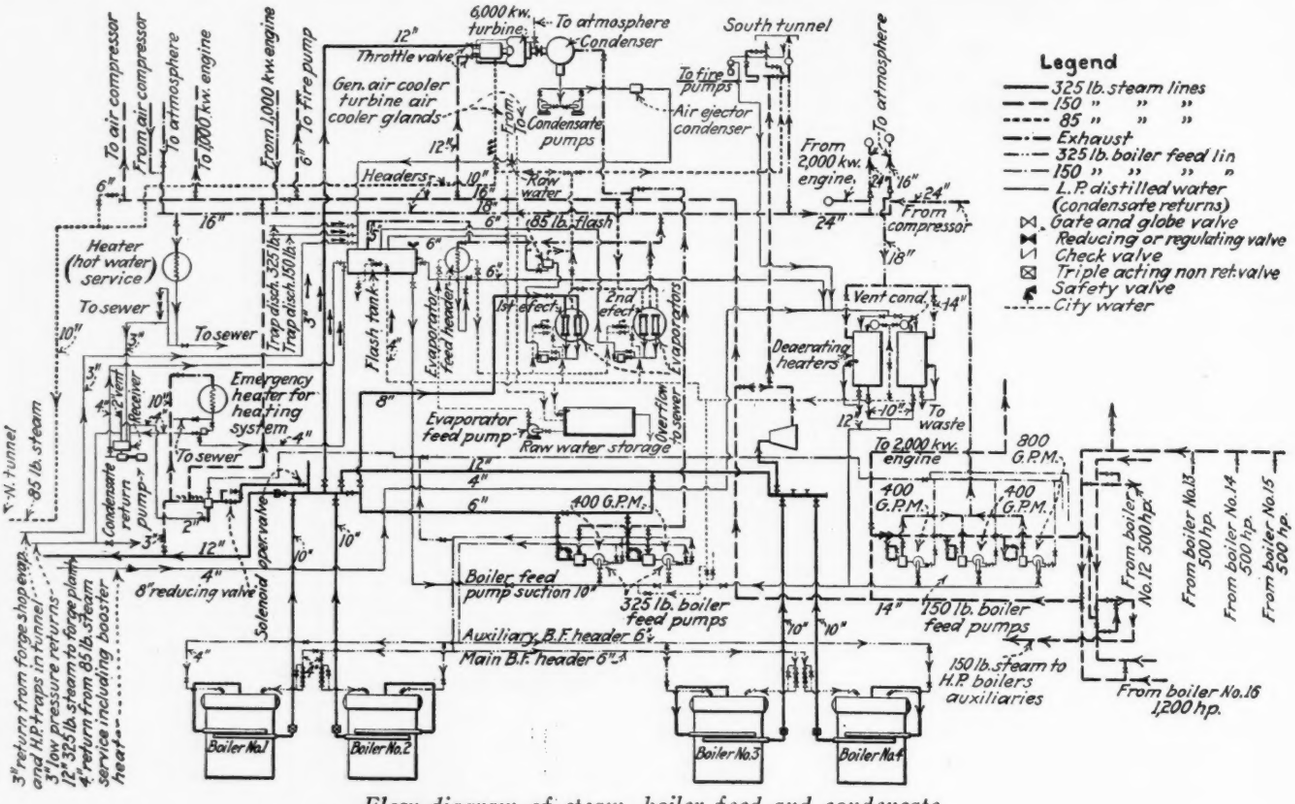
Generation of all steam is concentrated on a few highly developed units, on which the monthly average efficiencies are consistently recorded in excess of 80 per cent, with average production as high as one-quarter billion pounds per month.

Delivery and control of satisfactory factory heating has been solved and placed under the power-house operating staff. The absence of attention to the satisfactory heating of manufacturing areas alone makes this installation worth while, neglecting the important economic advantages of fuel saved for heating and the substantial proportion of the motive power generated for manufacturing purposes during the heating season, as a byproduct of heat delivered.

Every step in this program has first undergone an analysis as to engineering feasibility; has then been set up as an economic proposition, balancing the concurrent element of annual loads against the actual demands; and taking the earning power of the improvement as the difference between the gross savings that could be enjoyed and the fixed charges that must be carried as a continued burden, due to the tieing up of capital in the improvement. Each step that has been taken in the program will earn a net revenue averaging 30 per cent, in addition to contributing to the increased capability of the plant to meet the growing demands.

The estimated performance of the turbine operation, in connection with the hot-water heating system, was so thoroughly appreciated that the predicted operating chart, on which the preliminary calculations of system control were illustrated, was used as the controlling chart throughout the last heating season, and the byproduct power expected to be derived was at all times available when measured by the outside corresponding temperatures.

Boiler operation has shown the improvement anticipated from the introduction of the new units. Operating experiences with the boilers shows that the load will be handled normally at a comfortable rating of around 250 per cent at high efficiency and with negligible deterioration of the brickwork and stoker iron. Under emergency conditions these boilers will carry continuously 325 per cent of rating, still with excellent efficiency and good control, but with increasing maintenance cost per unit of time, but not per unit of output.

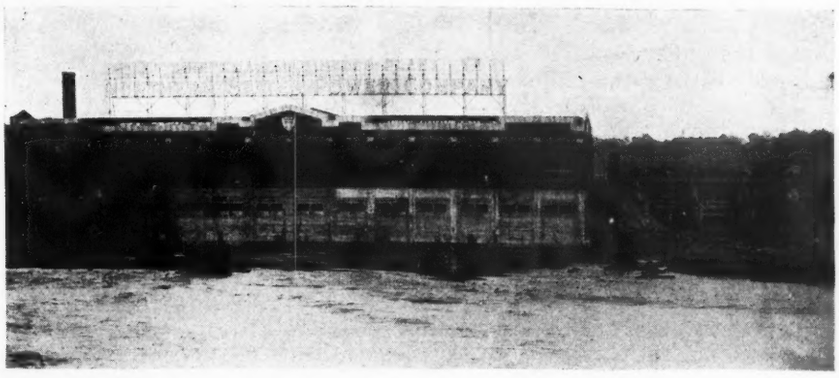


Flow diagram of steam, boiler feed and condensate

During a recent test on five typical days the following averages applied on one boiler: 24-hour rating, 239 per cent; 8-hour rating, 262 per cent; 4-hour rating, 273 per cent; 2-hour rating, 282 per cent. These are averages of ratings for the indicated periods occurring on five different days. The average preheat under the fire varied from 406 to 434 degrees.

In a recent test on one of the boilers, including not only normal full-load periods but banking hours, 2,000,830 lb. of coal was burned. The efficiency for the entire period, including banking hours that were necessitated, showed an over-all yield of 83 per cent of the B.t.u. fired in the B.t.u. delivered from the boiler.

In connection with the rehabilitation the engineering problems were innumerable, but the combined efforts of the engineers, together with the construction division of the owner, show that such a program may be effectively and profitably carried out.



Chippewa Falls plant operates under a 29.6-ft. head

PROPELLER-TYPE WATERWHEELS

Have Adjustable Blades

SOME six years ago, when the Northern States Power Company of Wisconsin, a Byllesby subsidiary, took over the hydro-electric developments on the Chippewa River, the water-power capacity of the system was increased to 49,800 kw. Of this amount, 39,000 kw. was available in a six-unit plant at Wissota, operating on a head of 55 ft. and provided with large storage capacity, and 10,800 kw. in a plant at Jim Falls. To provide seasonal regulation, a storage reservoir of twelve billion cubic feet capacity had been placed in service on the upper Chippewa River and a second reservoir of one-half that capacity on the upper reaches of the Flambeau River, a tributary stream.

To enhance the value of this regulation by making available 21,600 kw. additional power from the same water was the primary purpose of the newly completed development at Chippewa Falls, the plant under discussion in this article. The new plant is approximately two miles below the Wissota development and has been designed to operate in water synchronism with it. In other words, Chippewa Falls operates on the water discharged from the Wissota plant. This is readily feasible, as the new plant also has six units, and every time a machine is started at Wissota one will be placed in operation at Chippewa Falls. The capacities of the two plants are, therefore, approximately in the same ratio as the available heads, which, in the larger plant, is normally 55 ft. and in the smaller 29.6 ft.

With the large pondage at Wissota and the second regulation afforded by the two reservoirs the two plants are operated in unison on peak-load service. So long as the water is available they are operated up to full capacity for 18 hours a day or until the load drops off. At the low stages of the river the water is ponded at Wissota and the plants operated at maximum capacity for the number of hours that the supply will permit. Stream gagings running back to 1909 indicate a possible output of 80,000,000 kw.-hr. per year from the new plant.

Dividing the plant capacity into six comparatively small units has made it possible to load the various machines to the point of maximum efficiency, and in order that this efficiency may be maintained under varying conditions of operation, the six propeller-type machines in the new plant have been equipped with movable blades that may be adjusted to suit varying operating conditions. In a few minutes the pitch of the blades may be changed to give maximum efficiency for any gate opening or maximum output for any variation of head. Even with the storage provided, the advantages of such an arrangement are self-evident and should be enhanced if the plant ever should operate on stream flow.

The development called for the construction of a dam about 1,030 ft. long, including an earth embankment with a concrete core wall, a retaining-wall section 69 ft. long, a 572-ft. spillway section with thirteen Taintor gates and a sluice-gate section 64 ft. long; also the construction of a power house, located adjacent to the north bank of the river on the site of an old sawmill said to be the largest of its time.

The Taintor gates are motor operated through a worm-gear hoist and drum mechanism on the operating

Chippewa Falls hydro-electric development provides 21,600-kw. additional power from Chippewa River. This plant has six units and operates in water synchronism with the 39,000-kw. Wissota development two miles above and adds to the value of seasonal regulation through storage reservoirs. A feature of the new plant is the use of propeller-type turbines with movable blades that may be adjusted to maintain maximum results under varying operating conditions.

bridge. Owing to the fact that the Wissota pond is equipped for automatic spilling, so that at times there is more water available than the discharge from the turbines, two of the Taintor gates at the Chippewa plant are arranged for remote push-button control from the switchboard to facilitate caring for these sudden surges in the water supply. The other eleven gates are arranged for local control. Operation of the sluice gates is effected by screw hoists.

With a rise of two feet above the normal level of the pond the spillway is arranged to discharge 110,000 sec.-ft. of water. As this quantity is almost double the recorded flow of the river at this point, there should be little difficulty in keeping the level near to normal.

Hydracone Draft Tubes Used

Reference to the sectional elevation, Fig. 1, will show the general arrangement of the scroll case and the hydracone draft tube, the arrangement of the gates, trash racks with mechanical rake and the stop logs. The forebay is inclosed to prevent ice troubles on the racks, as at the latitude of the plant temperatures are low during the winter months.

In the power plant the generating units are spaced on 45-ft. centers. On the turbine deck are the circuit breakers and buses and the storage tanks and pumps of the oil governing system. The building is equipped with a 30-ton traveling crane and the forebay with a fifteen-ton crane of the same type for hoisting the headgates and the stop logs. In an annex at the north end of the building space is provided for the oil-filtering system, the cooling-water pumps, a storage room, the switchboard and transformers and a heating plant equipped with two boilers and coal storage.

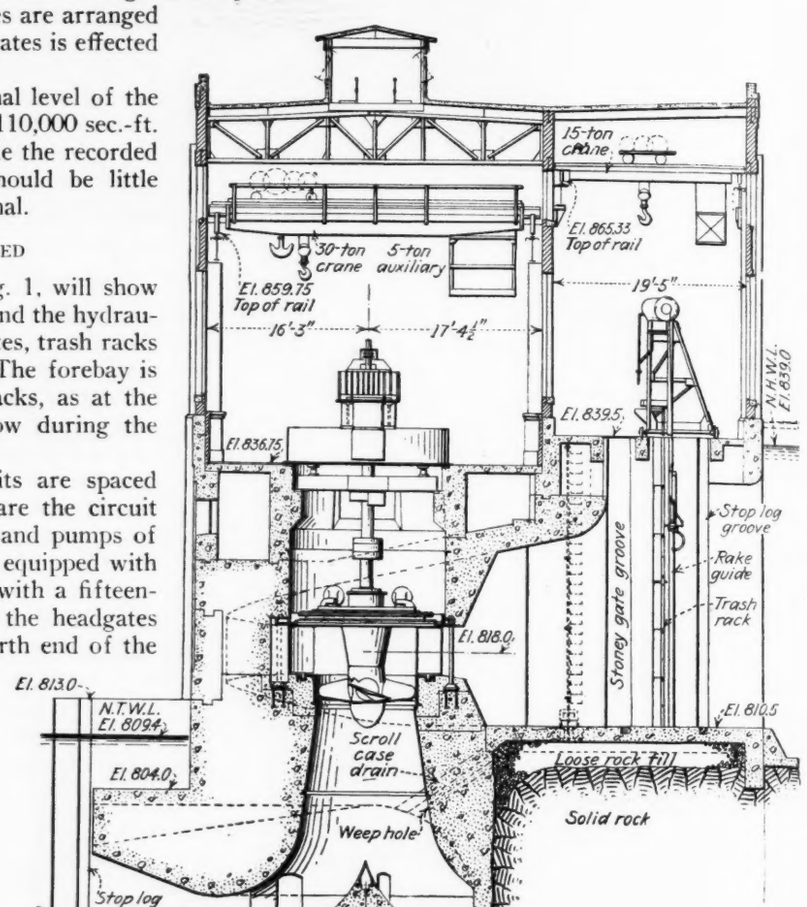
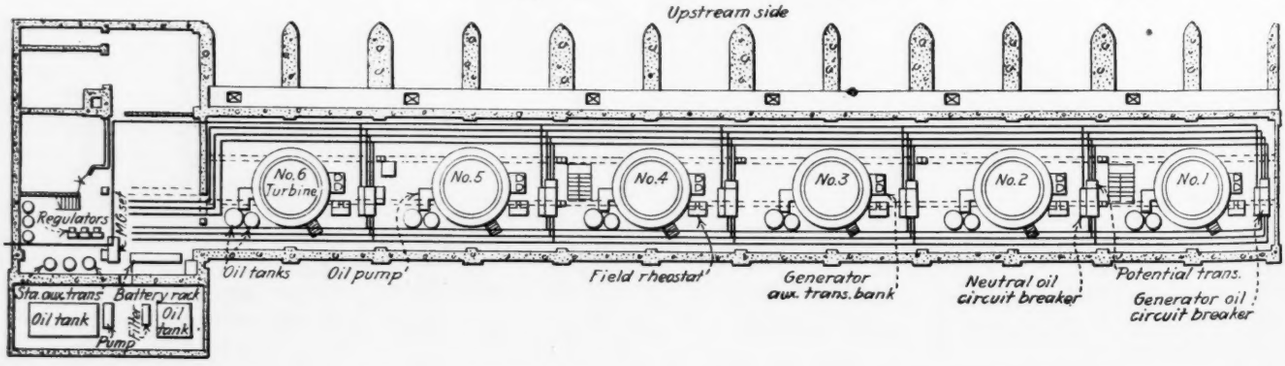


Fig. 1 (Right)—Cross-section of one of the units, showing 5,000 hp. propeller-type wheel with adjustable blades

Fig. 2 (Below)—Plan view of power house, showing the main electrical connections



For controlling the admission of water to each scroll case, one set of two gates of the Stoney roller type is provided. The gates are lifted vertically by the traveling crane over the forebay. With rollers traveling at one-half the rate of the gate, the friction is so small that there is no difficulty in moving the gates with the full head of water against them. Trash racks 19 ft. wide by 29 ft. high are built in upper and lower sections. To keep the rack bars clean, a mechanical rake mounted on a traveler is provided. The débris pulled up by the fingers of the rake is dumped on a platform above the operating deck, from which it is transferred into an industrial car to be carried to the end of the plant and dumped.

A full set of stop logs made of steel and concrete is provided for one scroll-case inlet. Weighing six tons each, these logs necessarily are handled by the forebay crane through a self-fastening and self-releasing hook fitting into slots at the centers of the logs. In front of the logs a curtain wall extending four feet below the level of the pond, prevents ice, logs and other floating material from reaching the racks. An added precaution is the use of a boom, built of squared timbers with fingers extending about four feet below the surface, which is anchored to the bank and the dam and to two intermediate crib piers. By the boom the trash that may collect is

directed to the sluiceway equipped with a 20x5-ft. gate that lowers vertically to open.

To keep ice from forming along the wall of the forebay and the dam, a bubbler system is used. Air is supplied at 80-lb. pressure by a motor-driven compressor and, after passing through a cooler to remove the moisture, is distributed to the various submerged nozzles that are spaced at the proper intervals.

Reference has been made briefly to the selection of turbines of the propeller type with blades that are adjustable for varying conditions. Adoption of the relatively high speed of 138½ r.p.m. has made it possible to keep down the size of the generators. The runner diameter is ten feet. The shaft is fifteen inches in diameter, and from the bottom of the runner hub to the top of the thrust bearing is 32½ ft. long. In addition to the thrust bearing each unit has three steady bearings.

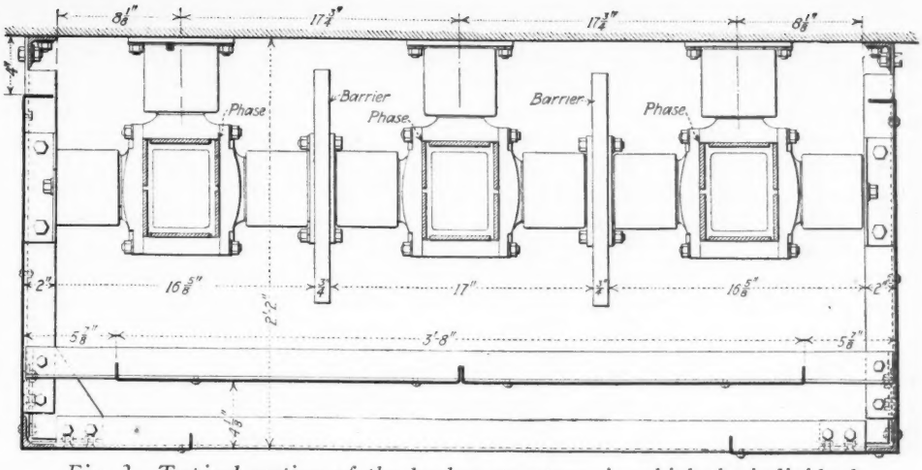


Fig. 3—Typical section of the busbar structure, in which the individual phases are accurately centered in the compartment

The busbars are of a special box type, that transmit the current with a smaller heat and magnetic loss than is possible with other types. This arrangement also permits better ventilation of the busbar structure.

At the normal head of 29.6 ft. each unit will pass about 1,750 sec.-ft. at full gate, making a total flow through the power house, when all six units are operating, of 10,500 sec.-ft. Although the guaranteed efficiencies at the normal head are 83 per cent for full gate capacity, or 5,000 hp., and 87½ per cent for 4,200 hp., results that are considerably better and may reach a maximum of 91 per cent are anticipated in operation from the waterwheels.

The waterwheels drive 4,000-volt three-phase 60-cycle vertical generators with direct-connected 50-kw. 250-volt exciters. Each generator is rated at 5,150 kva., delivering an output of 3,600 kw. at 70 per cent power factor to either one or two buses at 4,000 volts. These buses run the full length of the power house, about 350 ft., and transmit approximately 5,000 amperes to a bank of three 10,000-kva. outdoor transformers, which step up the generated voltage to 120,000 for transmission to the Wissota substation and thence over a 120,000-volt transmission line to Minneapolis and St. Paul..

Electrical Design

Because of the bus voltage being 4,000 and other conditions, a number of special features were involved in the electrical design of the power house. Economy of installation and preservation of space determined the location of the oil circuit breakers on the turbine-room deck adjacent to each unit. To assure safety of operation and maintenance, the oil circuit breakers were inclosed in steel cubicles, which also house the disconnecting switches tying the generator to either one of the two buses.

One of the outstanding features of the electrical installation is the design of the 4,000-volt bus. Being a

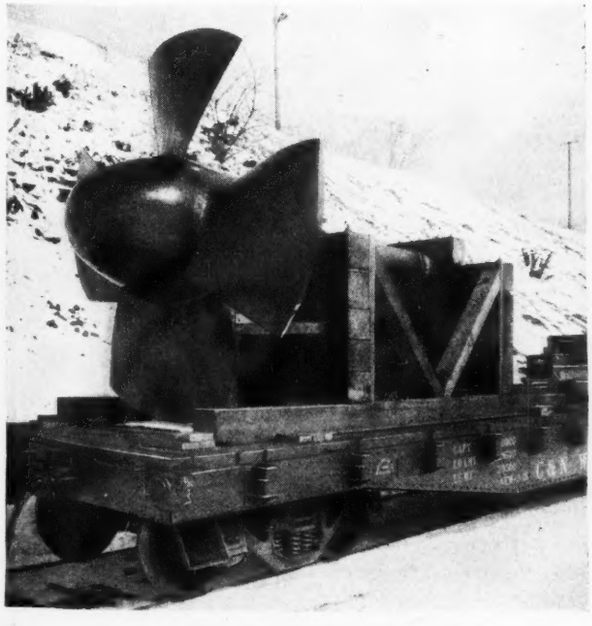


Fig. 4—One of the adjustable-blade propeller-type runners

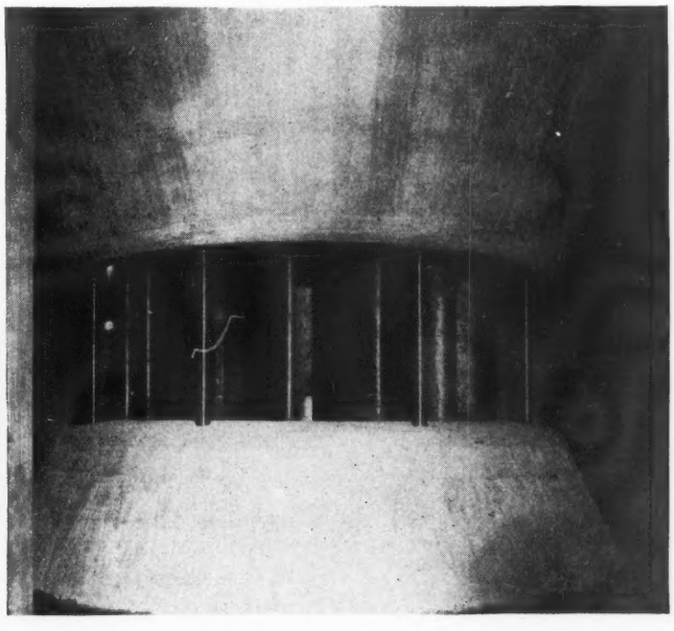


Fig. 5—Looking into the entrance to one of the waterwheels

special box type, the bus transmits the heavy current with smaller heating and magnetic losses and utilizes the full carrying capacity of the copper parts to a greater extent than would otherwise be possible. This arrangement also permits of better ventilation within the bus structure.

Fig. 3 shows a typical section of the bus in which the individual phases are accurately centered in the compartment by a three-way porcelain bus support and isolated by three-quarter-inch asbestos lumber barriers. From the viewpoint of safety of operation, it was found advisable to inclose the bus within a steel housing designed to permit free circulation of cooling air. A baffle at the bottom of the inclosure with necessary openings at the top of the sides was selected as the best means of effecting this result.

The problem of contraction and expansion of the copper bars and their relation to the concrete ceiling supporting them was solved in a simple manner. Expansion joints were placed every sixteen feet to minimize the expansion and contraction of each section to approximately one-sixteenth inch and, by practically eliminating the creeping effect of the bars, to allow more effective clamping of the bus structure. This comparatively negligible amount of expansion in each section simplified the design of the expansion joint, which is made up of twenty sheets of No. 32-gage leaf copper of the same width as the bars. This arrangement of the bus in sixteen-foot sections and the box design proved of great advantage in its construction and, later, the assembly of the sections in place.

Control Equipment Centralized

Control equipment is centralized at the switchboard in the control room at the north end of the plant. The operator at this switchboard has full control over the performance of the units, including starting and stopping. The operation of the units has been simplified to the extent that the only manual features involved are the closing of the starting switch by the switchboard operator and the synchronizing of each of the units as they are put on the bus. The remaining steps in the completion of the operation are automatic and enable the generators to assume their share of the load as predetermined by the load-indicating devices.

Emergency Shutting Down

An emergency means of shutting down the unit is provided at each generator in a location easily accessible to the floorman on duty. In addition to this each of the units is subject to automatic shutdown owing to any one of the following factors: Overspeed, hot bearings, low governor oil pressure, differential fault and loss of field excitation. This automatic shutting down of the unit is effected by a series of relays, any one of which will open the main circuit breaker and the field circuit breaker, close the turbine gates and set the brakes in proper sequence. Should it be desired, the control of the station at any time can be made fully automatic in its operation.

The switchboard in the control room is of an unusual design, inasmuch as structural tee irons and angle irons replace the bulky and unsightly pipe and pipe fittings. Eliminating the acorn nuts and through bolts from the front of the panels also improved the appearance of the board.

The arrangement of the auxiliary and control equipment has given a compact plant design that is economical in space requirements, but at the same time provides the desired operating conveniences.

The plant was designed and constructed by the Byllesby Engineering & Management Corporation, of Chicago, of which H. W. Fuller is vice-president in charge of engineering and construction; F. H. Lane, manager of engineering and construction; J. Wm. Link, hydraulic engineer; H. W. Eales, chief electrical engineer and W. T. Walker, general superintendent of construction. Details of the design of the plant were under the immediate charge of E. N. D'Oyly, electrical engineer, and Stephen Wehner, assistant hydraulic engineer.

PRINCIPAL EQUIPMENT CHIPPEWA FALLS PLANT

General

Location	On Chippewa River at Chippewa Falls, Wis.
Capacity	30,900 kva. or 21,630 kw. at 70 per cent power factor.
Operating company	Northern States Power Company, a Byllesby subsidiary.
Engineers and constructors	Byllesby Engineering & Management Corporation.

Power House

Turbines, six, propeller type with adjustable blades	Allis-Chalmers Mfg. Co.
Capacity each, 29.6 ft. head, 138½ r.p.m., hp.	5,000
Guaranteed efficiency at 4,200 hp., per cent	87.5
tems, six	
Oil pressure governing six	Allis-Chalmers Mfg. Co.
Power-house and forebay cranes, traveling	Cleveland Crane & Eng. Co.
Air compressor, 17 cu.ft. per min., 175 lb. pressure	Allis-Chalmers Mfg. Co.
Air compresson, 200 cu.ft. per min., 35-hp. motor	Ingersoll-Rand Co.
Oil purifier	Sharples Specialty Co.

Generating and Switching Equipment

Generators, six, 5,150 kva. at 0.70 power factor	General Electric Co.
Power transformers, four, 10,000 kva., 4 to 125 kv., watercooled	Westinghouse Elec. & Mfg.
Generator and transformer oil circuit breakers	General Electric Co.
Transmission-line disconnecting switches	Delta Star Electric Co.
Station auxiliary transformers, three, 150 kva., 2,300 to 230 and 115 volts	Westinghouse Elec. & Mfg. Co.
Station auxiliary transformers, three, 100 kva., 2,300 to 230 and 115 volts	General Electric Co.
Storage battery, 60-cell, 125-volt, control and emergency lighting	Electric Storage Battery Co.
Battery charging set, 10 kw., 140 volts	General Electric Co.
Lightning arrester, auto-valve type	Westinghouse Elec. & Mfg. Co.

Dam and Forebay

Gates, thirteen Taintor, four submerged sluice, one trash sluice, twelve head gates, Stoney roller type, trash racks and stop logs	Minneapolis Steel and Mach. Co.
Mechanical trash-rack rake	Newport News Shipbuilding & Dry Dock Co.
Hoists for Taintor and sluice gates	D. J. Murray Manufacturing Co.

Anchoring and Draining Underground Steam Lines

By M. W. Davidson

THE arrangement of details that constitutes a properly designed underground steam transmission line depends to a large extent upon the local conditions surrounding each project. Consequently, there is usually plenty of opportunity afforded the designer for the exercise of his originality and ingenuity.

It seems to be common practice, in laying out underground lines, to locate an anchorage and an expansion joint at the same point and in this manner to divide the entire line into expansion sections of the desired length, as illustrated at *A*, Fig. 1. While this practice may be best in certain cases, as a general rule it does not appear to be an arrangement that will yield the least expensive construction. If anchor points alternate with expansion points, as at *B*, Fig. 1, it may be possible to reduce the number of points along the line that must be constructed large enough to permit examination and attention to the expansion joints. In this arrangement the anchorages may be greatly reduced in size and general expense of construction, as the pipe expands both ways from the anchorage, and the friction over the guides and through the casing would be approximately equal in both directions. Thus the stress to which the anchorage is subjected is much less than where the anchorage and expansion joint are located together. In general the number of expansion points will be half those required in the arrangement shown at *A*.

A satisfactory method of anchoring lines may be had by the use of steel angles or channels set with ends embedded in the side walls of anchor pits or in concrete piers and with the pipe saddle and over-strap bolted

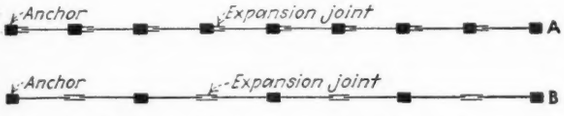


Fig. 1—Two methods of arranging anchors and expansion joints

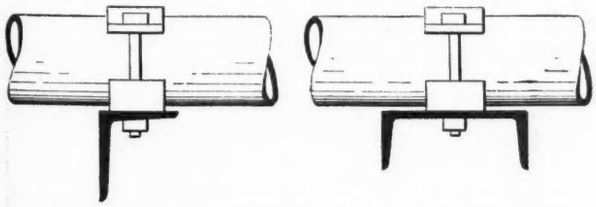


Fig. 2—Using structural shapes for anchoring pipe lines

securely to the angles or channels, as illustrated in Fig. 2. This is only one of many methods for constructing pipe anchorages, and there is plenty of opportunity for the designer to display his ingenuity in their arrangement.

Proper draining of underground steam lines is a prime necessity for satisfactory service. Its lack often results in ruptured lines and broken anchorages. Even if these do not result, wet steam and slugs of water are delivered to the supplied apparatus, often resulting in serious damage to it. The writer vividly recalls one instance where water hammer caused the failure of a 10-in. low-pressure underground line, the pipe being pulled apart at one of the couplings and a massive concrete anchor practically destroyed.

All underground steam lines should slope downward in the direction of the steam flow. If, however, it is impossible to obtain such a slope, then a slope in the opposite direction should be had. It is essential that the condensate should gravitate to the points of collection and drainage whenever the steam is shut off the line.

The arrangement of piping, receivers and traps for adequate separation of the condensate from the steam is a most important feature of line design and one that is

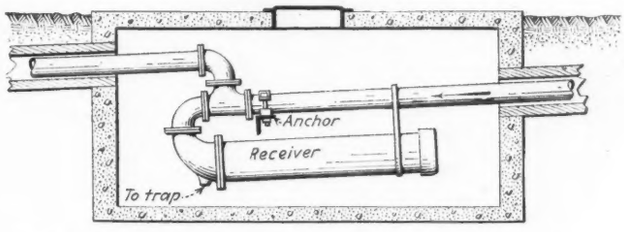


Fig. 3—An easily made receiver for pipe-line drips

often neglected. Wherever it is necessary to deliver dry steam, the use of separators is necessary, but for those lines that furnish steam to heating systems or to process systems, separators are not required. For the effective draining of heating lines the writer has found the construction shown in Fig. 3 to be satisfactory, the condensate being well taken care of even when the lines are started cold. The arrangement shown makes possible the grading of the line in the direction of the steam flow, although the terrain may actually rise in that direction.

Examination of Fig. 3 shows an arrangement for a combined anchorage and drainage point such as is referred to above. For anchorage the pipe is strapped down to a pipe saddle which rests on a cross-angle *A*. It should be observed that the condensate is delivered to the receiver through an opening the full size of the line, and that it is not diverted from the line of the steam flow until it is past the tee, out of the top of which the steam line is continued. With this construction large slugs of water are promptly cleared from the line into the large receiver, from which the water is removed through a trap. If the tee shown were turned with the run vertical instead of horizontal, one of the elbows shown would be eliminated. If such arrangement were followed, the branching of the line for the steam and water at the same point would result in less effective separation of water and steam, and particularly at those times when the quantity of water is great.

Again, in this construction the steam line is raised to a somewhat higher level by the use of the elbow attached to the top of the tee; or, if further rise is desired, by the use of a section of pipe between the tee and elbow. This rise affords opportunity for the downward sloping of each section of the main irrespective of the slope of the terrain, and the outlet of the entire line may be higher than the inlet and yet the water may gravitate to each drainage point in the direction of the steam flow.

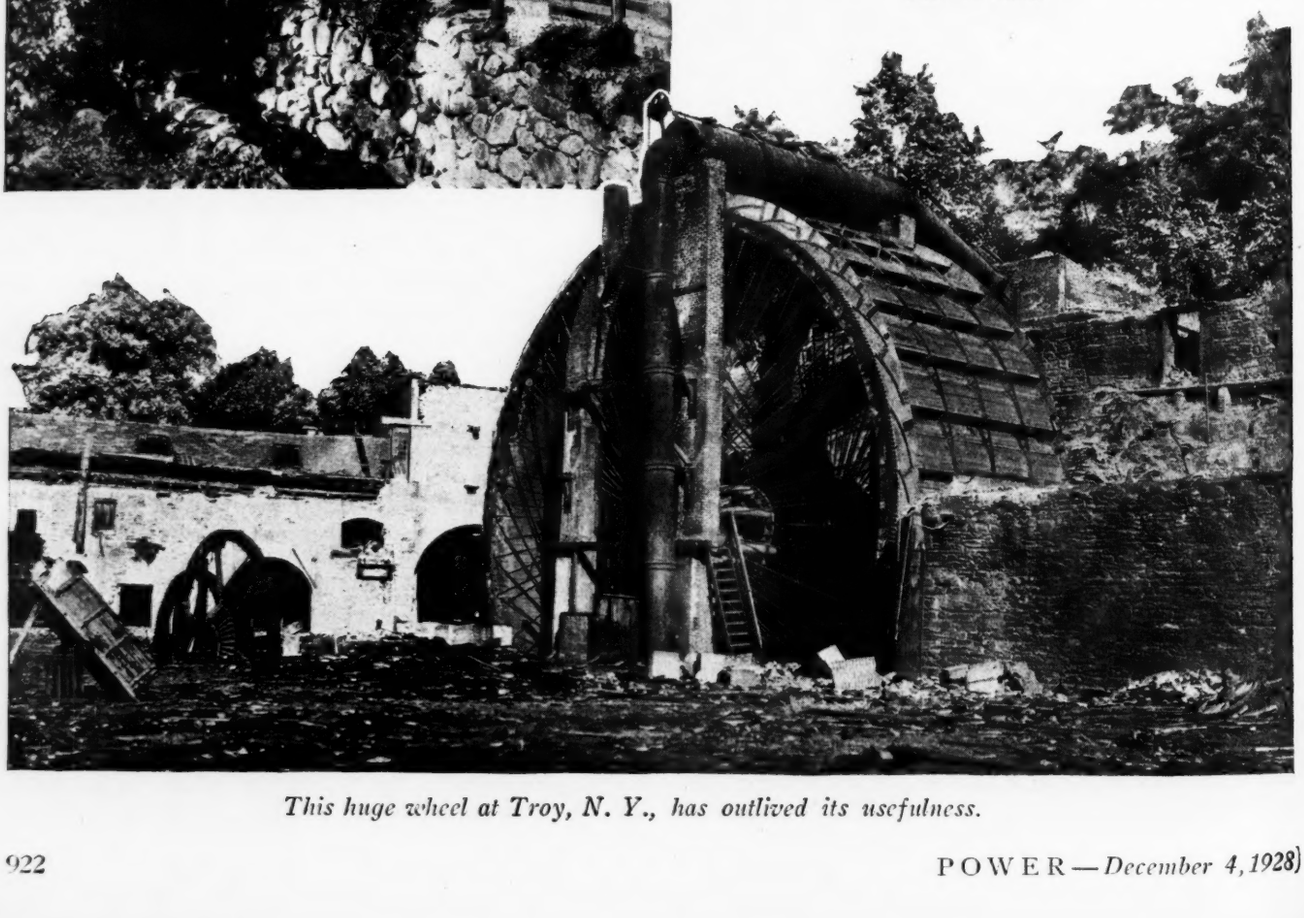
Receivers are cheaply and readily made from sections of large pipe. The pipe is capped at one end and flanged at the other for bolting to the connecting elbow. The trap should be connected to the lowest point of the receiver, and this may be either the cap end or the elbow end, depending upon the direction in which the connecting elbow faces.

YE OLDE WATERWHEELS

Left—A Japanese overshot waterwheel.

Below—A wheel still in use in Germany.

Left—A waterwheel and grist mill in Connecticut built in 1650



This huge wheel at Troy, N. Y., has outlived its usefulness.

Removing Water Vapor From Agitation Air

By M. F. Knoy

SINCE the advent of the high-pressure system of agitation in the raw-water ice plant, a great deal of interest has centered in the proper dehumidification of the agitating air.

There is a great deal of inconvenience in handling ordinary low-pressure drop tubes, hence it was desired to introduce the air through a tube permanently fastened to the can and running down an inner corner to a point near the bottom, or down the outside and up through the bottom. But the use of this kind of tube is impossible unless the air has been dehumified to such an extent that it will not deposit ice in the tubes at tank temperatures. Moreover, sufficient pressure will have to be maintained on the air to keep a passageway open through the ice as freezing proceeds. Both of these conditions have been successfully met in the modern system of high-pressure agitation.

Drying of the air may be accomplished in any of three ways: By cooling the air to a temperature below that of the freezing tank; by treatment with a hygroscopic chemical solution, and by cooling the air under pressure to near tank temperature and then expanding it to secure further drying.

When we speak of dry air, we do not mean that it contains no moisture at all, but that it is capable of holding more moisture and hence will not deposit any at the temperature in question. Since tank temperatures are always below the freezing point, any moisture deposited in the tubes would soon freeze and cause stoppage.

The following tabulation gives the amount of moisture in grains per cubic foot of saturated air at the temperatures indicated:

Temp. deg. F..	−15	−10	−5	0	5	10	15	20	25	30	35
Gr. water per cu.ft. air...	0.220	0.286	0.37	0.479	0.61	0.78	0.99	1.24	1.56	1.94	2.12

Thus we might have a tank temperature of, say, 25 deg. and by cooling the air to 20 deg. so reduce its moisture content that it could not deposit any at tank temperature. For when cooled to 20 deg. its moisture content could be as much as 1.24 grains per cubic foot, and when passed into the tank and warmed to 25 deg. it would be capable of holding 1.56 grains per cubic foot and would thus tend to absorb rather than deposit moisture. The difficulty with this method of drying is that there is not usually available in the ice plant a source of refrigeration sufficiently below tank temperature.

Next we might consider the use of a hygroscopic chemical solution. Sodium hydroxide, potassium hydroxide, sulphuric acid, ammonium chloride or calcium chloride might conceivably be used for this purpose, as all are very soluble in water. Any solution of mineral salt will reduce the normal amount of moisture in the air that is in intimate contact with the solution, and as a rule the stronger the solution the greater this reduction will be. Owing to its low cost and harmless nature calcium chloride is usually employed in this connection. If we dissolve 444 parts of this salt in 1,000 parts of water, we should have a solution that is 30 per cent calcium chloride by weight. It is a well-known law of physics that all aqueous solutions will show a lower tension of water vapor than does pure water. The decrease in the vapor pressure of the air immediately in contact with the solution is proportional to the increase in the amount of salt in its solution. This lessening of the vapor pressure is, of course, brought about by the solution absorbing part of the moisture in the air.

The tabulation taken from the Smithsonian tables gives the reduction in the vapor pressure in millimeters (one atmosphere being 760 mm.) due to the pressure of the gram molecules of calcium chloride per liter of water given at the head of the columns. This is for a temperature of 180 deg. Centigrade, at which the total vapor pressure of pure water is 760 m.m.

Gram Molecules of Calcium Chloride

0.5	1.0	2.0	3.0	4.0	5.0
17	39.8	95.3	166.3	241.5	319.5

The term "gram molecules" describes the number of grams in a liter per molecular weight. In case of calcium chloride, the molecular weight is as follows: Calcium, 40.07; chloride, 70.92; total, 110.99.

Using 111 as the approximate value and taking 4 gram molecules, there will be $4 \times 111 = 444$ grams per liter. As a liter of water weighs 1,000 grams, we have 444 grams of calcium chloride and 1,000 grams of water. This makes the salt 30.7 per cent of the solution.

Now as shown, a value of 4 gram molecules will reduce the vapor pressure 241.5 mm. or a reduction of $\frac{241.5}{760} = 32$ per cent, even though the total vapor pressure is not 760 mm., on which the tabulation is based. In other words, of the moisture in the air, if the latter is saturated, $100 - 32 = 68$ per cent will be left after contact with the solution.

Assume that we have a tank temperature of 20 deg. F. and that a chloride dehumidifier is kept at 25 deg. F. Now air at 25 deg. would, when saturated, carry 1.56 grains of moisture per cubic foot of air. After exposure to the calcium chloride brine spray it would have only $1.56 \times 0.68 = 1.06$ grains per cubic foot. This is less moisture than the air would normally hold even at 20 deg.; hence, when this air reaches the tubes and is cooled to 20 deg. it will still remain dry.

Because of practical obstacles to be overcome in the use of the chemical dehumidifier, it has not been generally accepted in the ice plant, though occasionally encountered in this field. We must, however, bear it in mind as a possibility of the future.

Lastly, we might consider the method of compressing the air, cooling it to near tank temperature, and then expanding it to the pressure required for agitation.

For example, assume a tank temperature of 20 deg., and assume that it is possible to cool the air to 25 deg.; also assume that 15 lb. gage is the pressure required for agitation. We know that the amount of moisture per cubic foot of saturated air depends solely upon the temperature and is independent of the pressure. Hence, if we have one cubic foot of air at 60 lb. abs. pressure, containing one grain of moisture, when expanded to 30 lb. abs. there will be two cubic feet and the one grain of moisture will be divided between the two, giving 0.5 grain per cubic foot on the expanded air. It is thus seen how air is dried by expansion. Then to go back to our problem, we see by the table that at 25 deg. the moisture content of the air is 1.56 grains per cubic foot and that at 20 deg. it is 1.24. The 15 lb. gage pressure is approximately 30 lb. abs. Hence we may say, $1.24 : 1.56 :: 30 : X$. Solving, we find $X = 37.8$ lb. abs., or about 23 lb. gage. Allowing a small margin for safety, we conclude that a

pressure of 24 or 25 lb. gage should be maintained on the air in the dehumidifiers in this particular case.

From the principle of the foregoing solution it will be seen that by watching the temperature of the air leaving the dehumidifiers as compared to tank temperature, the operator will be able to determine whether or not there is sufficient difference between the high and low air pressures to secure the proper drying effect.

If the air leaves the dehumidifiers at very nearly tank temperature, the high pressure may be lowered and a saving in compressor power thus realized. And if for any reason the proper cooling is not obtained in the dehumidifiers, the operator can secure dry air to the cans by raising the pressure sufficiently. Care must be exercised in this connection to see that the pressure is not raised far enough above normal to subject the air compressor motor to a dangerous overload.

This method of dehumidification is entirely successful and is widely used in the ice plant. Its only drawback is the rather large amount of power required by the air compressor, which usually amounts to 4 to 6 kw.-hr. per ton of ice made.

Boiler-Room Instruments or Automatic Combustion Control

By L. W. Hayward
Combustion Engineering Corporation

Industrial power plant owners and engineers, when installing new boiler plants or remodeling old plants, are confronted with the question of whether they can afford to install indicating and recording instruments to guide them in the efficient operation of their boilers and if they can afford to purchase automatic combustion-control equipment for regulating the furnaces to obtain better efficiencies than those obtained by hand operation. If their capital expenditure is limited, they want to know which will be the best investment, metering equipment or automatic control apparatus. Both are of real value for the efficient production of steam, but we will check into the results obtained by each class of equipment to see which should be purchased first.

Metering instruments for indicating and recording the quantities of fuel, air, steam and water, and gages for indicating and recording drafts, temperatures, etc., picture to the operators what the boilers are doing. Such instruments guide them in making the proper adjustments of fuel and air and show the results of changes made. In addition to this they indicate when the boilers are dirty inside and out and need cleaning, when the fuel beds are full of holes or badly clinkered, and when infiltration of air through leaky settings demands attention. In addition to telling the operators how to burn intelligently the coal intrusted to them, they actually record the results obtained so that the management can analyze the power cost, decide upon the best fuel to purchase for the efficient operation of the plant, and determine whether the equipment they have is economical.

It should be remembered that instruments can improve the efficiency of the plant only to the extent that the operators use them as a guide in their work. It is because operators do not always make the best use of instruments that automatic combustion control is needed. It is impossible for firemen to follow all the adjustments that are necessary when they have a number of boilers to take care of, or to follow the adjustments of even one boiler when the load conditions are not steady. When automatic control is used, these adjustments are made simultaneously and in proportion to load changes. The proper ratios of fuel, air and water are maintained over wide ranges of load variation, and the variables due to the human element are eliminated so that better efficiencies are obtained.

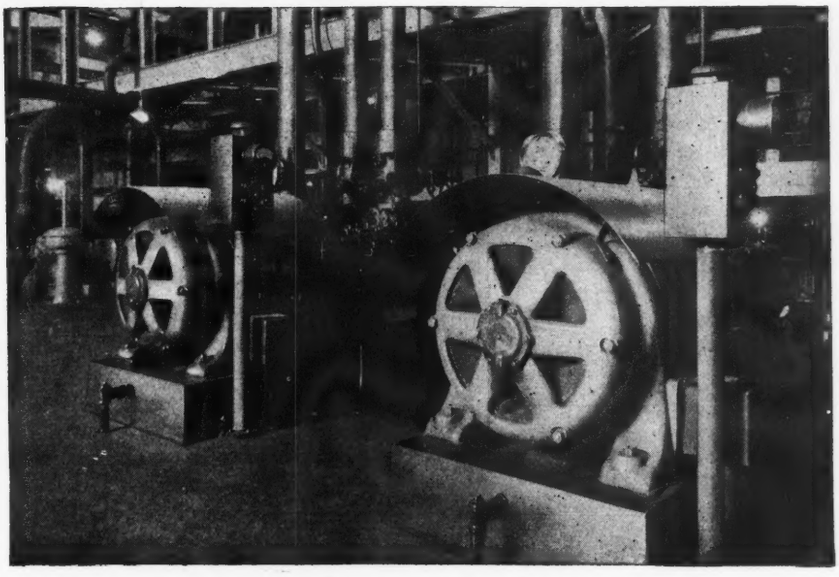
Although automatic combustion-control equipment makes the necessary adjustments in fuel, air and water according to load demand without the aid of instruments or operators, the efficiency obtained depends upon the original adjustment of the control for the proper performance of its duties and upon the continual readjustment to allow for changes due to varying grades of fuel as to heat value and physical properties. The operators depend on the boiler-room instruments to tell them when these adjustments are necessary and when they have been properly made. The improvement in efficiency due to the use of automatic combustion control depends entirely upon the accuracy of the instruments from which the controls are adjusted and the degree to which the operators can interpret the meaning of the instruments.

In plants where automatic control apparatus has been installed previous to the installation of metering equipment, its value depended upon the guesswork of the operators in making the proper adjustments or upon the original adjustments made by the manufacturer at the time it was installed. There are plants where controls are installed that have never been readjusted since they were first put in operation by the manufacturer, because the operators have not been instructed as to how to make adjustments or provided with the proper instruments to aid than in making these changes. In plants were instruments are installed prior to the installation of control apparatus, the operators learn the value of the instruments and what they mean, and later, when control is installed, they are able to make the proper adjustments to obtain the full improvement in efficiency for which it is designed. Although instruments do not act directly to improve power-plant efficiency, they serve as a guide to the operators who have direct charge of the fuel used, and when automatic control is installed, they serve as a guide to the setting of the controls that determine the resulting efficiency.

Boiler-room instruments in themselves are a valuable asset to the efficient burning of fuel, while automatic combustion control obtains its real value only when used in conjunction with these instruments.

Operating Methods that Save

Before operating methods can accomplish a 100 per cent job in keeping cost low, the right equipment must be used. This is just as true of the motors and controllers used on the pumps in the power house as it is of industrial applications. In the next issue the article "Motors and Controllers for Power House Pumps" tells the kind of electrical equipment to use on these drives.



Two 600-hp. ball-bearing induction motors driving boiler-feed pumps

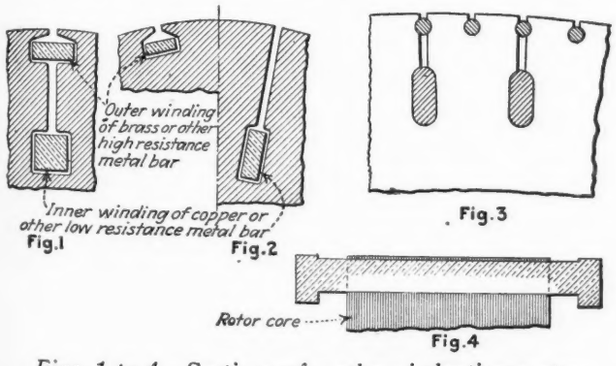
Recent Trends in
MOTOR APPLICATION

By W. A. Black

Chief Engineer,
Indianapolis Works, Fairbanks, Morse Company

DURING this period of falling prices, when the most careful consideration is being given to excess costs, it is only natural that motor applications should keep pace with the developments of the time. Individual drives necessitate subjecting the driving motor to the dust from the product of the driven machine. In many installations it is necessary to place the motor where it is not easily accessible for servicing. This condition made it evident that motor bearings must be sealed against dust in the atmosphere, and the windings protected.

Several methods were developed to seal the bearings, all of which were successful. Of these the adoption of anti-friction bearings is the most popular. This popularity can be attributed to the bearings not wearing enough during their normal life to permit the rotor to rub the stator core. They do not require frequent renewal of the lubricant, and since grease is used, it is easy to apply without spilling on the motor or floor.



Figs. 1 to 4—Sections of modern induction-motor squirrel-cage rotors

Figs. 1 to 3—Different arrangements of double-squirrel-cage windings. Fig 4—Shaded area shows distribution of current at starting in one bar of a high reactance squirrel-cage winding.

When anti-friction bearings were first employed in general-purpose motors, it was thought by some engineers that their use would be limited to motors of relatively small capacity. The size of motors equipped with these bearings has gradually increased until now they are used with entire satisfaction on ratings as large as 600 hp. The successful performance of the larger anti-friction bearing motors now in service gives data for equipping motors up to 1,000 hp. capacity.

Protecting the motor windings from dust in the atmosphere was accomplished by the inclosed self-ventilated type, in which the windings are inclosed with dust-tight covers, and cooling is effected by means of a blast of air directed against the covers. Such motors should appropriately be called "secondarily ventilated," since the cooling air does not come in direct contact with the windings. One type of this motor is shown in Fig. 4.

In the automobile industry, where entire buildings are given over to grinding gray-iron castings, serious trouble is encountered from winding failures caused by iron dust. This dust causes the best of insulation to fail, and the only real solution to the problem has been the inclosed ventilated motor.

The application of induction motors to individual drives necessitated higher starting torque and lower starting current. Individual drive took motor starting out of the hands of the electrician and placed it in the hands of the machine-tool operator, and this made automatic or push-button starters necessary.

Automatic starters for standard squirrel-cage motors are of the transformer type in order to reduce motor voltage during the starting period to a value that would insure starting current within the N.E.L.A. ruling. Since this type of control was expensive, it was evident that a motor that could be started at full-line voltage and develop sufficient torque for ordinary applications would have wide popularity.

Automatic-start motors, having phase-wound rotors with some automatic means of changing the resistance of the rotor during the starting period, were placed on the market by a number of manufacturers. These motors met the requirements so far as starting torque and starting current were concerned. However, they did not have the desirable features of the substantial squirrel-cage rotor construction.

In order to furnish automatic, or full-voltage start, squirrel-cage induction motors, an old principle was revived in which the rotor was furnished with two squirrel-cage windings. This type of motor has the usual distributed stator winding, and a rotor with two sets of bar windings displaced radially one above the other, as shown by Fig. 1, or staggered, Fig. 2, or a combination of the two, Fig. 3, with twice as many bars in the outer winding as in the inner winding.

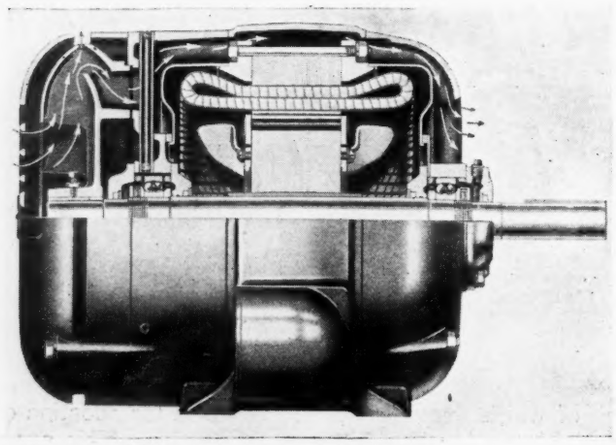


Fig. 5—Section through an inclosed self-ventilated type motor with air-cleaning feature

Air is drawn into the motor by a fan on the left-hand end. In passing through the fan the air is cleaned, the dirt is discharged outside the motor and the clean air flows through the machine as indicated by the arrows. Note, the cooling air does not come in contact with the winding, but passes between the inner and outer shells

The outer, or starting, winding is designed with high resistance to give high starting torque with relatively low starting current. The inner, or running, winding is designed with low resistance to give low rotor losses under normal running conditions.

At starting, with the rotor at standstill, the rotor winding is subjected to line frequency which produces a high reactance in the inner winding. This high reactance restricts the induced current in the inner winding to a comparatively low value and forces the greater part of the rotor current to flow in the outer high-resistance starting winding. Since the starting torque is proportionate to the I^2R losses in the rotor winding, the rotor current through the high-resistance winding produces a high starting torque.

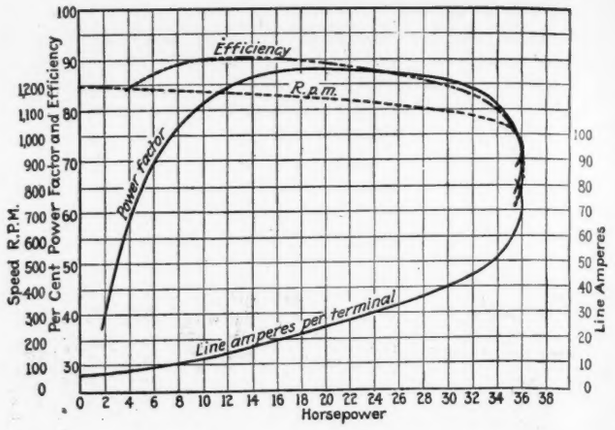


Fig. 6—Performance curves for a 20-hp. 1200-r.p.m., three-phase 60-cycle 440-volt, double-squirrel-cage motor

As the rotor speed increases, the rotor frequency decreases, which in turn causes a proportionate reduction in the reactance of the lower, or running, winding, and more current flows in this winding. At normal speed the reactance is relatively low, allowing a greater portion of the rotor current to flow in this winding.

This automatic-start motor, known as a double-wound-rotor motor, is well suited for such drives as compressors, plunger pumps, conveyors and hammer mills. When designed for 8 to 10 per cent slip at full load, they give excellent service when driving heavy-duty punch presses. In fact, it has been possible to make a material reduction in the motor capacity for a given press application. This is possible because the double-wound-rotor motor has a higher starting torque than the standard squirrel-cage motor from which the motor capacity was originally decided upon.

Double-wound-rotor motors have replaced slip-ring motors on many applications which previously could be started only by slip-ring motors. In the case of a heavy-duty brake-drum drawing press, a 75-hp. 1,200-r.p.m. slip-ring motor was replaced with a double-wound-rotor motor of the same capacity, with entire operating satisfaction and with the added advantage that maintenance of slip rings, brushes and control contacts was eliminated.

This type of motor produces starting torques of from

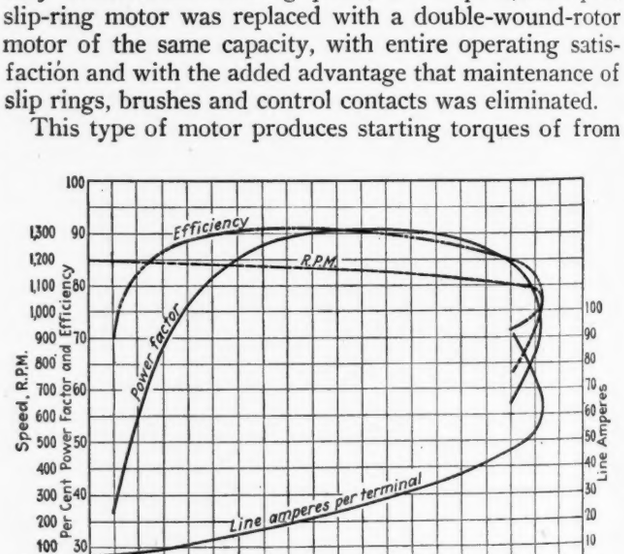


Fig. 7—Performance curves for a 20-hp. 1,200-r.p.m., three-phase, 60-cycle, 440-volt high-reactance squirrel-cage motor

200 to 250 per cent of full-load torque when started at line voltage, and in sizes 30 hp. and smaller draws a starting current within the recommendations of the N.E.L.A. The running performance approximates but does not equal that of the standard squirrel-cage motor. Fig. 6 shows typical performance curves of a 20-hp. 1,200-r.p.m. three-phase 60-cycle 440-volt double-wound-rotor motor.

Many applications, such as centrifugal pumps, machine

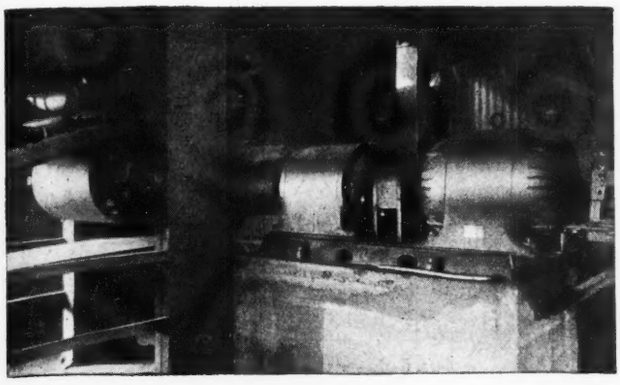


Fig. 8—Totally inclosed squirrel-cage motor driving a belt conveyor through a speed reducer

tools, fans and other similar applications which are started and driven by standard squirrel-cage motors, do not require the high torque produced by the double-wound-rotor motor. For such services the single-wound deep-bar or high-reactance squirrel-cage motor has been placed on the market. This type of motor develops a starting torque averaging 150 per cent of full-load torque and draws a starting current at full voltage within the recommendations of the N.E.L.A.

When a thin wide copper bar is embedded in a magnetic material, such as bars located in slots in the rotor core, the current at high frequencies is forced into that portion of the bar nearest the air gap, as shown in Fig. 4. At standstill or low rotor speed current flows in only the shaded portion of the rotor bar, as shown in Fig. 4. Since the starting torque is proportionate to the I^2R losses in the rotor winding, restricting the rotor current to the upper portion of rotor bars increases the torque to a value larger than would be obtained if current flowed through the entire bar. The increased effective rotor resistance reduces the starting current as described for the double-wound-rotor construction.

As the rotor accelerates, the rotor frequency decreases, thereby decreasing the rotor reactance and the rotor current spreads through the bar, until at normal speed the current is nearly equally distributed. Since the entire bar is active at normal speed, the rotor losses are low, which results in higher efficiency than could be obtained with a fixed rotor resistance sufficient to develop the torque obtained by the high reactive effect. Fig. 7 shows the performance curves of a 20-hp. 1,200-r.p.m. three-phase 60-cycle 440-volt, high-reactance motor.

The line-start motors have the advantage that they can be started at full voltage by means of a magnetic contactor, while the standard squirrel-cage motor is usually started at reduced voltage. On the other hand, the standard squirrel-cage motor has the advantage that its efficiency may be 1 or 2 per cent and the power factor 3 to 4 per cent higher.

Since the double-wound-rotor type will develop considerably higher starting torque than the others, it has a definite field for services that require a high starting torque. The high-reactance line-start motor and the standard squirrel-cage motors are both suitable for the large majority of general-purpose applications. Each of these types can be furnished in the open, totally inclosed or inclosed self-ventilated construction.

During the last few years speed reducers have become more popular in slow-speed applications such as conveyors, rotary kilns, cement screens, coal-hopper feeders and elevators. By their use high-speed motors can be coupled to slow-speed loads. High-speed motors have better operating performance than low-speed machines of the same capacity. The improved efficiency is practically offset by the speed reducer losses, but the higher power factor reduces the line losses and improves line regulation.

One of the most severe starting loads that can be successfully started with a squirrel-cage motor is a hammer mill. The large torque necessary to accelerate the high-inertia rotor in a comparatively short time necessitates a motor having a substantial rotor construction. The double-rotor squirrel-cage motor has been found to have the starting characteristics necessary for successful performance in this service.

When located near the end of a light power line, a compensator type of starter will reduce the starting current to approximately 200 per cent of full load. This low current will in most cases permit the use of a squirrel-cage motor where it was formerly necessary to use a slip-ring motor.

In summing up the recent improvements in motor design which have made improved application possible, we have:

1. Improved starting, which permits individual drive

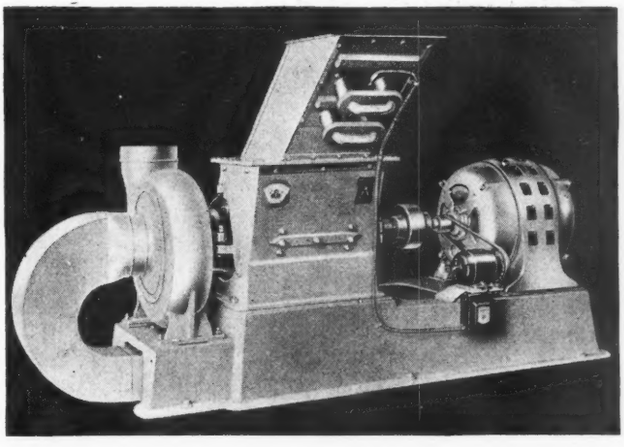


Fig. 9—Hammer mill directly connected to a 75-hp. 3,600-r.p.m. ball-bearing double-squirrel-cage motor

for practically all types of machines. Full voltage start permits the use of simple moderate-priced push-button control.

2. Anti-friction bearings, which permit protection against dust, reduce lubricant, protect windings from becoming oil soaked and prevent the rotor rubbing the stator core.
3. Inclosed self-ventilation, which permits protecting the windings from injurious effects of dust in surrounding atmosphere.

Analyzing the Products of Combustion*

By A. A. Potter and H. L. Solberg

ANALYSIS of the products of combustion is ordinarily made by means of an Orsat. The analysis is made over water at a constant pressure and temperature, so that the gases are saturated with water vapor. Consequently, proportionate parts of the water vapor are absorbed at each step in the analysis and it can be assumed to be an analysis of the dry products of combustion. The CO_2, CO and O_2 are absorbed by chemical reagents, and the nitrogen is determined by subtracting from 100 per cent the sum of the percentages of CO_2, CO and O_2. The SO_2 is absorbed as CO_2, but generally causes an error which is within the limits of the experimental errors made in collecting and analyzing a sample of gas. For a discussion of the methods of manipulating an Orsat the reader is referred to the instruction sheets of the manufacturers of the apparatus, to Bulletin No. 97 of the Bureau of Mines, "Sampling and Analyzing Flue Gas," by Henry Kreisinger and F. K. Ovitz, or "Power Plant Testing," by Moyer. A good Orsat is an essential piece of equipment, and no power plant should be without one.

In analyzing the products of combustion, a sample of gas may be obtained at any place between the fuel bed and the chimney. Simultaneous samples are often taken at several points in the boiler, economizer, and preheater settings in order to determine the quantity of air leaking into the settings. Ordinarily, however, the sample is collected at the point where the gases leave the boiler heating surface before they pass through the damper.

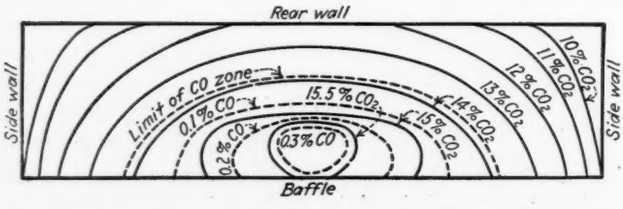


Fig. 1—Composition of the products of combustion at section through the gas passes at end of last pass in water-tube boiler

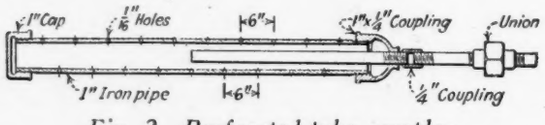


Fig. 2—Perforated-tube sampler
(From Bureau of Mines Bulletin No. 97)

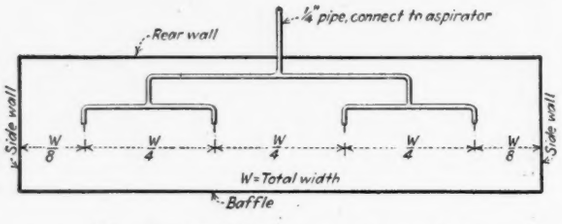


Fig. 3—Multiple open-end sampler

The importance of collecting a representative sample of gas cannot be emphasized too strongly. No matter how carefully the analysis may be made, the results are no more accurate than the original sample. On account of air infiltration around doors and through cracks in the brickwork, stratification and poor mixing, the composition of the gases is not uniform across the gas passages. The CO_2 is generally a maximum at the center and decreases toward the side walls because of air leakage. CO may be present in considerable quantities at certain points, and large amounts of excess air may be found at other points, all at the same cross-section of the gas passages. Fig. 1 shows the variation is gas composition at the end of the last pass in a water-tube boiler. Although the gases have passed over the entire boiler-heating surface and around two 180-deg. bends, stratification is pronounced and the collection of a representative sample under such conditions is difficult.

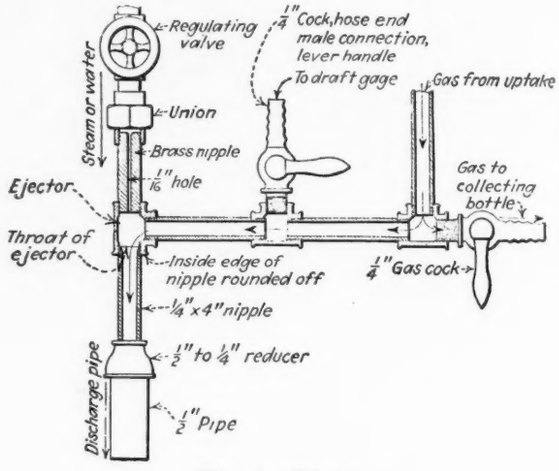


Fig. 4—Ejector
(From Bureau of Mines Bulletin No. 97)

The common method of collecting a sample is to insert a piece of $\frac{1}{4}$-in. pipe into the gas passage with the open end at the center of the cross-section. The collection of a representative sample of gas with an open-end sampler under conditions such as are shown in Fig. 1 would be extremely difficult if not impossible. An attempt is sometimes made to collect a representative sample by plugging the end of the tube and drilling a few holes along its length. Unfortunately, the suction is greatest near the discharge end of the tube and equal quantities of gas will not be drawn through each hole. This difficulty can be overcome by the use of a sampler such as is shown in Fig. 2. Such a device must be removed from the setting frequently in order to clean the soot from the small holes. Compressed air is sometimes piped to the sampler to be used in cleaning the holes without the necessity of removing the sampler from its position. Fig. 3 shows another type of sampler which will not become plugged with soot so easily and which gives a reasonably accurate sample of gas.

While an Orsat can be connected directly to the end of the sampling tube, it is more convenient to use an ejector and two aspirator bottles for collecting the sample of gas. The hook-up of this apparatus is shown in Figs. 4 and 5. The ejector works on the same principle as the ordinary injector used to feed boilers. It may be supplied with either water under pressure or steam. When the ejector is turned on, a steady stream of gas will be sucked through the sampler and discharged down the discharge pipe of the ejector. A sample of gas can then be

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collected in the upper collecting bottle by first filling this bottle with water and then permitting the water to flow into the lower bottle. The flow can be regulated so as to collect a continuous sample over a period of several hours.

When a sample has been collected in the upper bottle, it can be analyzed by connecting this bottle to the Orsat apparatus, transferring the hose on the lower bottle to the side connection and placing this bottle above the one that contains the gas sample. This will put the gas under pressure and force it into the Orsat. By means of suitable piping and valves the sampling tubes in each boiler

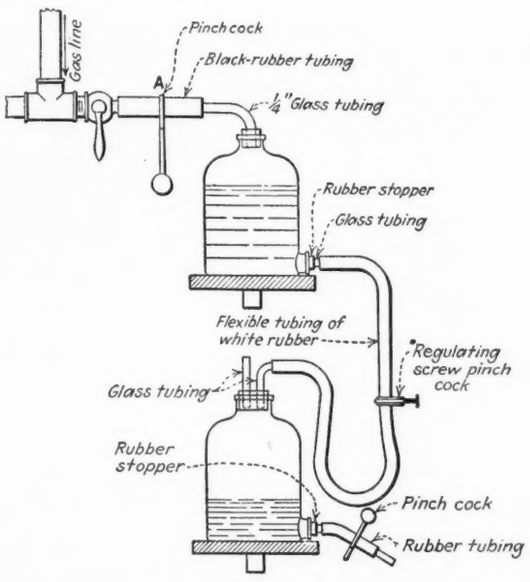


Fig. 5—Sampling bottles

in the average-sized plant can be connected to the same ejector. Samples of gas can then be collected from any boiler in the plant, either for checking CO_2 recorders, checking the combustion conditions or for test purposes.

Since CO_2 is soluble in water, the sample should be analyzed as soon as it is collected. Tests conducted by the Bureau of Mines indicate that the amount of CO_2 dissolved in water when the gas sample is in contact with a water surface for two hours, is negligible. This error can be reduced by using a brine solution in the collecting bottles and can be entirely eliminated by using mercury. However, such refinements are not warranted except in very carefully conducted tests and where an unusually good sampling tube is in use.

Automatic Motor Control in Pumping Station

BY C. S. LUMLEY

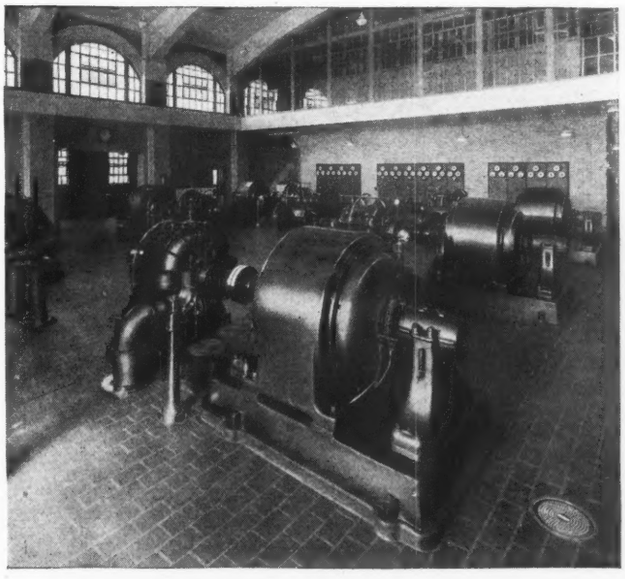
Electrical Engineer, Smith, Hinchman & Grylls

AS AN electrical application the motor-driven high-pressure pumping station for fire service in the business district of Detroit is of interest from the viewpoint of automatic motor starting, even though the installation dates back to 1922. This station contains six five-stage centrifugal pumps, each rated to deliver 25,000 gal. per min. against a head of 300 lb. The pumps are driven by 700-hp. slip-ring induction motors taking three-phase 60-cycle 4,400-volt current and operating at a speed of 1,200 r.p.m. High-tension primary service is supplied directly by two independent service lines from separate substations of the power company's 4,600-volt system.

Occasion to operate the plant develops only in case of fire in the downtown district provided with high-pressure service. Maintaining the service in accordance with the volume and pressure requirements at the fire is accomplished by passing the necessary proportion of the pump discharge back to the water gallery from which the pumps derive their suction. The amount of this by-passed water is regulated through hydraulically operated valves controlled by small pilot valves located at the switchboard and at the pumps.

Automatic starting of the pumping units is effected by means of three accelerating relays per motor, timed for predetermined current values through three stages of resistance in the motor, each stage of resistance being automatically cut out of the circuit by its relay as the motor comes up to speed. The stator side of the motor is thrown directly across the line.

Each motor has its own separate high-tension service through an individual solenoid-operated oil circuit breaker, and the closing of this circuit breaker automatically closes the control circuit for starting the motor. The circuit breakers are inclosed in modern concrete high-tension compartments with asbestos doors. All disconnecting switches are motor operated and are so interlocked that the cell doors cannot be opened nor the dis-



High-pressure pumping station for fire service in the city of Detroit

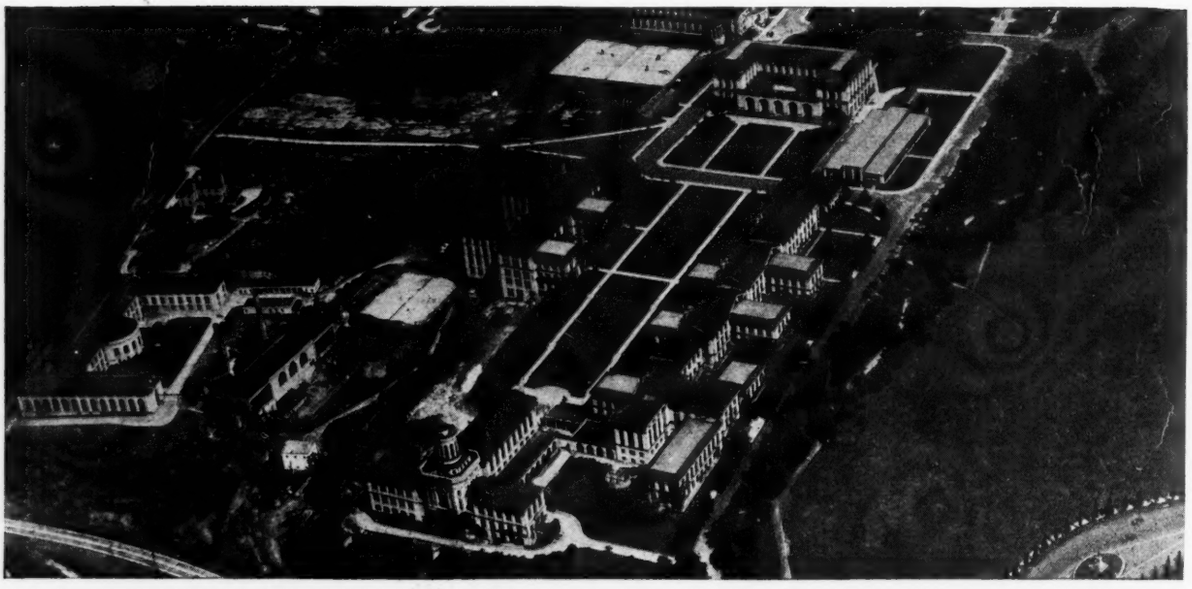
connecting switches operated until the oil circuit breaker has been tripped. The oil switches, disconnecting switches, miscellaneous valve motors and the lighting are operated on direct current at 125 volts. Power service for the auxiliary equipment in the station is 220-volt alternating current.

A.S.M.E. Report

THE A.S.M.E. Annual Meeting, boiled down for busy engineers, will be spread before *Power* readers in the December 11 issue.

Fuel and Economic Changes

Forecast by Pittsburgh Coal Conference



World's Foremost Power Engineers and Fuel Technologists Profit from Second International Meeting at Carnegie Institute of Technology

COAL has a place of importance in modern industrial life that is sometimes not appreciated by the power-plant engineer. It is not only a fuel for power plants, but it is also the raw material for many industries, the basis of a myriad of products. If the Second International Conference on Bituminous Coal, held in Pittsburgh, Pa., Nov. 19 to 24, 1928, had held no other lessons, it would have been of value to the power field for the emphasis placed on this fact.

When a conference draws, as this one did, the leading engineers and scientists of the world whose interests are in any way connected with coal, it has an import far outreaching its immediate subject. As Dr. T. S. Baker, president of Carnegie Institute of Technology, pointed out in his address of welcome to the assembled delegates, the international understanding and good will that grow out of the common discussion of problems centering on the utilization of this basic material of civilization, may far exceed in value the industrial information exchanged, important as that is.

Over 1,800 delegates from some twenty countries and from a large number of learned societies, institutions and industries, gathered in Pittsburgh to hear and discuss 110 papers covering all phases of the use of bituminous coal. For the convenience of those in attendance the meeting was divided into five general sessions: Seven low-temperature carbonization sessions, two high-temperature carbonization sessions, three dealing with pulverized fuel, four dealing with power and combustion, two on the origin and composition of coal, three on coal washing and preparation, three manufactured-gas sessions, two fertilizer sessions, two tar and oil sessions, and two dealing with coal liquefaction.

Many of the papers given at the general sessions dealt with research topics having no immediate significance for power engineers. Others were suggestive or directly applicable. Dr. Carl Krauch, director of the Interessengemeinshaft Farbenindustrie, Ludwigshafen, Germany, told how the coal liquefaction plant operated by his company is turning out 40,000 tons of gasoline from coal as the raw material in 1928, and in 1929 will turn out 250,000 tons. The process there used can produce other liquid fuels beside gasoline and will undoubtedly have an effect on the future relative balance between steam and internal-combustion engine power.

In an address on the relations of "Coal, Hydrogen and Capital," by F. zur Nedden, secretary of the fuel committee of the German National Coal Bureau, Berlin, the trend toward the supplanting of raw coal by higher grades of fuel, such as processed coal and oils, was pointed out. However, in the face of this trend, the world consumption of raw coal is still increasing.

While in the United States the tendency to use higher fuels than raw coal is met largely by the great local

supplies of petroleum and natural gas, Europe has no such resources upon which to fall back. However, although fifteen years ago 52 per cent of all coal mined in Germany went to the ultimate consumer in the raw state, this figure is today but 40 per cent. Transportation of coal in the shape of electric power is partly responsible for this change, while low-temperature carbonization and the hydrogenation of coal are having an increasing effect.

This trend is bringing about a new relation between fuel and capital. The higher the quality of the energy form into which coal is transformed, the greater is the amount of capital that must be invested per ton of coal so used, as represented by the equipment necessary to carry out the process.

When looking at electric generation and distribution from this angle, it becomes evident that effort applied to reducing the amount of coal required to generate electricity is of less importance economically than efforts that reduce the high capital investment required for generation and application. It also becomes evident that such processes as the hydrogenation of coal to improve its energy value require less capital expenditure than do steam-electric plants, and there is, therefore, good prospect for the future use of such processes, combined perhaps with oil engines, for power generation.

F. zur Nedden

H. C. Parmelee, editorial director of the McGraw-Hill Publishing Company, and formerly editor of *Chemical and Metallurgical Engineering,* in speaking on " A Chemical Engineering View of Coal Processing," dwelt briefly on the use of binary-vapor systems of power generation. The mercury-steam system, as used by the Hartford Electric Company, was not thought susceptible of wide application, because of the wholly inadequate resources of mercury. The organic chemical, diphenyl oxide, also is not available for use in such a system, because its properties are not entirely suitable. The closely related material, diphenyl, is more promising. In any case, the chemical engineer is today almost ready to assure the power engineer that he will be furnished a boiler medium affording not less than 40 per cent and probably nearly 50 per cent thermal efficiency when operating at present temperatures and pressures.

George Claude, the eminent French scientist, in a paper that discussed some of the processes that he has developed, gave some information concerning his method of obtaining power from the sea in tropical regions there is about 25 deg. C. difference in temperature between the water at the surface and that in the depths.

Pulverized Fuel

The importance of pulverized bituminous coal as a fuel was reflected in the three sessions devoted to its discussion. At the first session much interest was taken in a paper by Rudolph Pawlikowski, General Manager of Kosmos Maschinenbauenstatt, that dealt with the conversion of a Diesel engine for burning pulverized coal. The engine, which was rebuilt for this research work, was a vertical 80-hp. four-stroke-cycle Diesel built by the Augsburg-Nuremburg Engine Works. Alterations were made only to the fuel admission gear, so that the finely pulverized fuel is first fed into an antechamber by a screw feeder, and is then forced from it into the engine cylinder with compressed air against a compression pressure of 430 lb. per sq.in. When burning coal, the engine has developed 110 b.hp., in spite of a 0.24 in. increase in the diameter of the upper end of the cylinder due to the wear that has resulted from 12 years of research and development work with coal fuel. The author claims this engine produces a kilowatt-hour on about 11,500 B.t.u. A complete description of the engine was published in the July 24, 1928, issue of *Power.*

A rather general paper on pulverized fuel, by Dr. G. E. K. Blythe, general manager, The Buell Combustion Company, Ltd., was read by Professor Estep. The paper opened with a brief description of the combustion processes that occur when pulverized coal is burned. In the remainder of his paper Mr. Blythe discussed driers, transportation of pulverized coal, and burners.

Henry Kreisinger, Combustion Engineering Corporation, in his paper, "Burning of Bituminous Coal in Pulverized Form," first compared the burning processes of gas, liquid fuel and solid fuel, explaining why in the case of solid fuel it is desirable to maintain high relative velocity between the coal particles and the air required for combustion. He then described the vertical, horizontal and tangential methods of firing pulverized fuel, and indicated that the vertical firing is particularly suitable for burning coals with low volatile matter, while the tangential method makes possible higher rates of combustion.

At the second session on pulverized fuel Dr. Ing. P. Rosin, Mining Academy of Freiberg, Germany, presented a paper on "Thermodynamic Basis of Pulverized Coal Combustion." As the result of various tests he determined that the influence of temperature on the maximum obtainable rate of heat liberation was twofold. With decreasing temperature of the combustion space the possibility of heat liberation rises, but on the other hand the reaction velocity drops. It is therefore desirable to lower the gas temperature in the combustion space as much as possible without impairing the velocity of combustion. The means to this end are cooling surfaces in the furnace, preheating of air, fine grinding and turbulence.

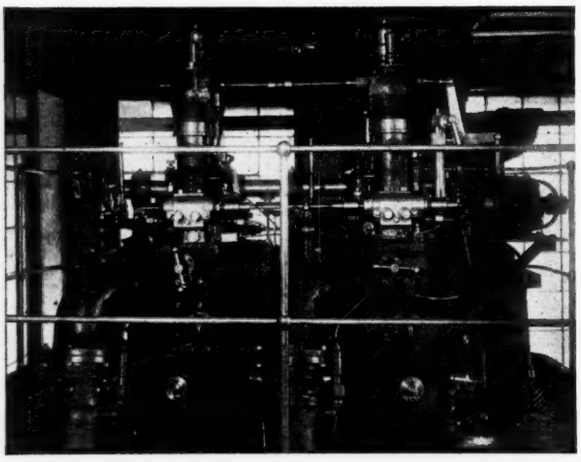
J. W. Armour, vice-president and engineering manager of the Riley Stoker Company, Worcester, Mass., delivered a paper on the "Modern Stoker and Its Comparison with Pulverized Coal Firing." The use of pulverized coal brought out the limitations imposed by the conventional methods of building boiler furnaces, and resulted in widening the scope of pulverized coal firing. The natural sequence was to apply to stokers those devices which have contributed to the success of pulverized-fuel firing.

Three outstanding factors that have contributed to the advance of burning coal on fixed grates—use of preheated air, proper applications or admission of air to

the fuel bed and substitution or supplementing of refractory lined furnaces with water-cooled or air-cooled walls —were discussed.

In the paper the author compared two unusually similar plants operating under the same management and load conditions. Test on the stoker-fired plant indicated an efficiency of 83 per cent, while the daily average efficiency is between 76 and 77 per cent. The results of operating the pulverized-fuel plant are so close to these that there is little to choose between the two methods of firing.

It must be admitted, Mr. Armour states, that where load conditions are such that there are long banking



The Rupa Coal Dust Engine

periods, the stand-by loss with pulverized coal is less than with stokers.

It is the author's opinion that the art of burning bituminous coal has reached a point where it is difficult to choose between pulverizers and stokers.

The progress that has been made in the adaptation of pulverized fuel to marine boilers was outlined in a joint paper by C. J. Jefferson, United States Shipping Board, and Commander J. J. Broshek, Fuel Testing Plant, U.S.N. One of the most difficult problems encountered in firing with pulverized fuel is the equal distribution of coal and primary air to the three furnaces of the Scotch marine type of boiler. A recent development, expected to eliminate this difficulty, is a combined pulverizer burner and fan unit for each furnace. The unit is very compact, and although no test data were presented, the authors expressed entire satisfaction with its preliminary operation.

In answer to inquiries by J. C. Hobbs it was learned that the length of flame as observed on board the "Mercer" was about seven feet, that ash was removed from the furnace every fourteen days and that using soot blowers every four hours was sufficient to keep the boiler flues clean.

In the paper, "Transportation of Pulverized Coal," by Dr. Ing. H. C. Gossens, Aachen, Germany, the interesting fact was disclosed that consideration was being given in Germany to the development of central coal-pulverization plants, and that for the purpose of transporting the pulverized fuel from the central plant to the point of utilization, special railroad cars have been built and used successfully. These cars have upright reservoirs arranged to discharge the fuel by compressed air. A 27-ton car can be emptied in a half hour, using 282.5 cu.ft. of compressed air per ton of pulverized coal.

The first of four sessions on power and combustion was devoted to a consideration of ash problems. A new method for the determination of the ash melting processes was presented by Dr. Karl Bunte, Karlsruhe. Any method of testing the fusion of ash, Doctor Bunte believes, should take into consideration the influence of an oxydizing or reducing atmosphere on the ash fusibility, and also the fact that ash is not a homogeneous substance, but is composed of plant ash, stone and slate.

In the new method developed by Doctor Bunte, the change in volume of a comparatively large cylindrical ash sample heated uniformly in an electric furnace and in an atmosphere of CO_2 is followed by means of a carbon feeler rod whose motion is graphically recorded. Several samples of the resulting curves were shown which indicated that the ash melting process often takes place in several distinct stages.

In an effort to develop a laboratory test that would serve as a reliable index to the behavior of ash in a boiler furnace, Prof. T. E. Estep, Carnegie Institute of Technology, made a study of the effect of various constituents of coal ash upon its fusion temperature. The results of this work he presented by curves in a paper "Clinkering of Coal Ash in Boiler Furnaces." While he found that ash containing relatively high percentages of pyritic sulphur or alumina generally had low fusion temperature, nevertheless there were a sufficient number of coals in which this was not true to make these factors unreliable indexes.

"The Removal of Ash and the Loss of Carbon From Boiler Furnaces" was discussed in a paper by Dr. D. S. Jacobus, Babcock & Wilcox Company, and E. G. Bailey, Fuller Leigh Company. After reviewing various methods of ash removal now in common use, Mr. Bailey, who presented the paper, pointed out that the latest method of removing ash from a pulverized fuel furnace is to tap it out in a molten condition. By locating the burners near the bottom of the furnace and directing the flame against the pool of molten slag, the entire accumulation of slag can be kept molten, and as 20,000 to 30,000 lb. of molten slag can be tapped out in an hour, ash need be removed only once a day.

In burning pulverized coal the factors that govern the carbon loss are character of coal, fineness of pulverization, burner design, furnace temperature, rate of combustion and excess air. Curves plotted from data obtained from tests on several different boilers were presented to show the effect of these factors on carbon loss. The conclusions drawn from these data were that the carbon loss in the flue dust from pulverized coal fired furnaces increases with anthracite or coal with high fixed carbon, coarser pulverization, cold furnaces, delayed mixture with air, low excess air, and high rates of combustion.

In discussing the paper Martin Frisch, Combustion Engineering Company, expressed the opinion that some of the differences found in the results might be due to the method of testing the ash. In reply to questions by Mr. Andrews, Mr. Bailey disclosed that molten ash removal had been successfully used in furnaces up to 25x20 ft. and that the side walls of the furnace must be cooled.

Prof. A. G. Christie's paper "Boiler Furnaces for Bituminous Coal," was presented by Prof. W. J. Huff, and gave a clear insight of the trend of boiler furnace design. One of the significant factors has been the great increase in efficiencies at high ratings which reflects the progress that has been made in combustion methods.

Professor Christie believes that refractory walls will continue to be used in boiler furnaces with stokers when not subjected to high ratings, but the demand for smaller furnaces with pulverized coal and for increased ratings will lead to the construction of entirely water cooled furnaces.

Slag formation in boiler tubes is a serious problem in many cases when the boiler is operated at high ratings, and, according to Professor Christie, is generally due to the projection by the flame of fine ash particles in a liquid state against the tubes. The remedy is to increase the furnace volume, or to modify the burning process so that combustion is completed before the gases reach the tubes.

In general, furnaces will be built to secure maximum heat generation per cubic foot of furnace with minimum excess air, and as a consequence the highest possible furnace temperatures will be developed.

A written discussion by H. C. Porter took issue with Professor Christie's statements that air does not reach the coal substance until the distillation process is nearly completed. R. J. S. Pigott presented curves showing how flame turbulence has caused peak efficiency to occur at higher combustion rates. In commenting on the present status of stokers he remarked that poor air distribution was an important factor, limiting their performance, but that stoker efficiencies within one per cent of that possible with pulverized fuel were now attainable.

J. C. Hobbs, Diamond Alkali Company, Ohio, related his difficulties with slagging and "birdnesting" of boiler tubes. This trouble was remedied by lowering alternate first-row boiler tubes, which also secured a 40-deg. drop in flue-gas temperature.

New Combustion Cycles Suggested

"The Kilowatt-Hour and Thermal Economy of Its Production," a paper presented by A. R. Smith, General Electric Company, reviewed many of the methods that have been tried to improve thermal economy, including binary vapor cycles. Whatever may be accomplished along the lines of improving the heat cycle should not prevent an attempt to introduce new "combustion cycles." In this respect Mr. Smith suggests two methods: first, to produce as byproduct domestic coke, tar oils and gas, and to burn the coke breeze or any of the residue fuel for making power. The second method is to gasify the coal completely, extracting the tar oils or the light oils for sale, and use the resulting gas for power generation. The author points out that gas fired boilers could be located out of doors in almost any climate, as they should require little attention, which would result in a considerable reduction of boiler house first cost.

Another paper that also suggests a change in the present "combustion cycle" was "Carbonized Fuel—How Will It Be Burned?" by M. Alpern, president, American Engineering Company, Philadelphia, Pa.

From various data which the author presented he concludes that low-temperature coke will form a good fuel bed on stoker grates, will move freely and maintain uniform permeability to the draft, will not swell or stick, will show a combustibility rate greatly exceeding that of ordinary cokes or even of coal, and will require less velocity of air to maintain a given combustion rate. These burning characteristics will tend to lower the installation costs by lessening required furnace volumes, lessening fixed charges by improving the capacities attainable with high efficiency, and may lower the labor costs and maintenance by increasing the smoothness of and maintenance by increased smoothness of operation.

By recovery of oils and gas worth $1 to $1.75 per ton of coal, and by utilization of all possible waste heat, the cost of carbonizing would be more than covered. There would remain the economies in furnace cost and operations to be developed so as to offset a substantial part of the loss of 25 to 30 per cent in total available heat of the fuel due to carbonization.

The author indicates that the type of plant he is considering would utilize the low-temperature char immediately in a stoker without intervening water quenching.

He, however, sounds a warning, that in any event the margin of profit to be obtained in such operation is bound to be small, and for this reason plant units of large capacity and with steady operation on full loads are required.

Low-Temperature Carbonization

Many papers were presented in the seven sessions devoted to the subject of low-temperature carbonization, covering all phases of this topic. Most of this material was of little direct interest to the power engineer, dealing, as it did, with the technic of processing. However, through many of these papers ran an undercurrent of distinct importance to the power field.

It is becoming apparent that low-temperature processes cannot, at this time, find an economic place in the United States solely on the basis of the solid fuel turned out, except perhaps in certain restricted localities, Nor can the tar oils, if made in large quantities, bring profit enough to make this carbonization method profitable. So those interested are turning to the allied fields of manufactured gas and power generation in the hope that a combination of one or both of these industries with their processes will provide the path to economic success.

In this movement, they are being met at least halfway by the utility companies. Thus it came about that one paper read dealt with the K.S.G. low-temperature plant that is being erected in New Brunswick, N. J., where the rich gas from the process will be mixed with blue gas and sold on contract to the Public Service Gas & Electric Company for distribution to retail consumers. It is expected that this will enable the plant to operate in such a way that the high-grade solid fuel produced can be sold where it finds its best market—as domestic fuel—in competition with established fuels.

Another paper discussed a tie-up between an electric generating station and a low-temperature carbonization plant—the Philo station of the American Gas & Electric Company and the Carbocite process. This has already been in successful operation and has recently been doubled in size. The carbonizing plant supplies high-grade fuel to the boilers and at the same time makes available a relatively inexpensive, smokeless domestic fuel.

Certain European developments in this line contemplate the production of fuels suitable for marine and stationary Diesel engine operation. Others are showing more success than formerly in carrying out the main object of this process as developed across the water—the production of smokeless fuel for domestic consumers and tars to take the place of imported petroleum.

All in all, the conference gave the distinct impression that low-temperature carbonization processes are slowly but surely being brought to successful operation and, as this occurs, are finding their economic place on both sides of the Atlantic. It is becoming increasingly necessary for large power producers to keep the possibilities of such combinations as were mentioned in mind when planning the erection of new generating stations.

Right Out of the Plant

BOILED-DOWN EXPERIENCE PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING

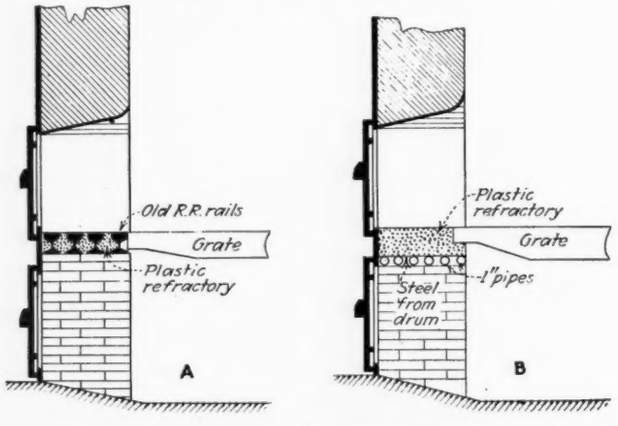
A Home-Made Refractory Dead Plate*

THE ordinary cast-iron dead plate used under a horizontal-return-tubular boiler is subject to warping and breakage, since it is exposed to high temperature. These dead plates must frequently be replaced.

The figure shows two practical methods of building permanent refractory dead plates. These methods of construction make it possible to replace a broken or burned-out dead plate without the loss of time and the expense involved in getting a new one of cast iron.

At *A* the dead plate is constructed of old railroad rails cut to the proper length to span the ashpit and rest on the side brickwork, with the spaces between the rails filled with plastic firebrick. If the rails available are much deeper than the end of the grate, it will be found advisable to use an angle iron for the grate, to rest on.

In the method shown in sketch *B* the dead plate is constructed of pipes not smaller than one inch in diameter, which span the ashpit. These pipes are then covered with the steel sheet of the container in which the refractory is shipped. Over this base five or six inches



Two methods of constructing dead plates with plastic firebrick

of plastic furnace lining is then pounded in. An angle iron should be inserted to carry the end of the grate. When baked out, plastic firebrick gives a monolithic, one-piece dead plate.

K. B. WILT.

Chicago, Ill.

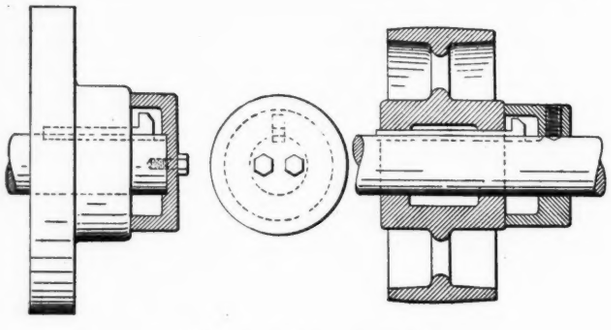
Safety Guards for Exposed Keys

ABOUT a year ago our company put on a "safety-first" campaign with a view to reducing the accidents around the power and manufacturing plants, and the decrease in accidents since that time has proved the move to be well worth while.

The campaign consisted essentially of putting guards around flywheels, belts and any exposed rotating member, and the method we used to cover projecting keys, of which there were many, is shown in the illustration.

Three types of covers were used, two of which are illustrated. Where the cover could be placed over the end of the shaft, as in the left-hand illustration, it was recessed slightly to center on the shaft and was held in place by two capscrews. One screw would be sufficient to hold the cover, but it necessitates destroying the center in the end of the shaft.

The other type shown was used where the shaft extended on both sides of a coupling or pulley. It so happened that just at that time we were making extensive alterations to our manufacturing plant, so in re-



Types of covers used

assembling the drives the covers were slipped over the shafting before the pulley and couplings were put on.

In cases where the drives were not touched, a similar cover made in halves was used; it was clamped to the shaft by two capscrews inserted in recesses so that the heads came below the surface of the guard. A close-fitting lock washer was used below the heads of the capscrews. These guards have been in use about a year now, and not one has loosened on the shaft, and as a safety device they have proved satisfactory.

Newark, N. J. C. A. LEONARD.

How Condensate from Heating Mains Was Used as Sealing Water on Turbine Glands

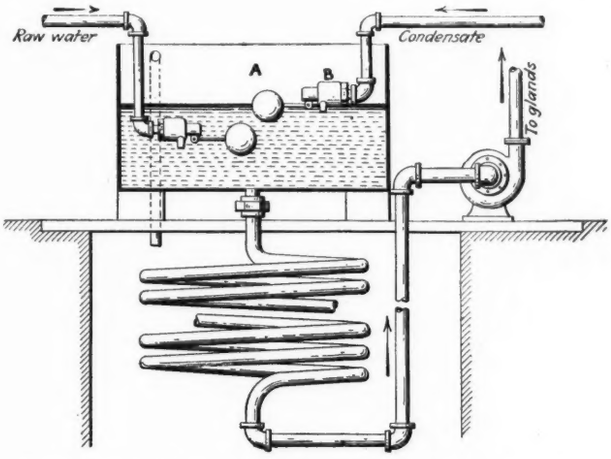
VARIOUS ways of purifying water for our turbine glands were suggested to us by the makers and others. Most of them were "partial" purifiers. It was thought that our boiler feed water contained too much scale-forming material for safe use on the gland.

Our heating-system mains are always active owing to considerable steam being used for various purposes the year round. There is always quite a flow-back of condensate. This was considered a source of suitable water, but it was too hot for gland use. Some time before there had been a leak in a nest of coils in our ammonia condenser and the nest had been replaced. So we hit upon the idea of installing one of the removed coils vertically in the cold well of the turbine condenser to cool the condensate. The condensate was piped to tank *A*, through float valve *B*, as illustrated. The tank was con-

*Copyright, 1928, by Plibrico Jointless Firebrick Company.

nected to one end of the vertical coil in the cold well and a centrifugal pump to the other end, which delivered the water to the glands of the turbines. The water, in passing through the coil was cooled sufficiently for gland use. Raw water was also connected to the tank for emergency use.

Our turbine runs continuously five and one-half days



Condensate from heating main was used for turbine gland water by cooling it in cold well of condenser

a week except for holidays and when down for overhauling. Since we began using this water, the glands have remained free of scale.

Elgin, Ill. W. L. PARKER.

Heating Water With Steam Coils

THE calculations necessary to determine the time required to heat a tank of water with a given size steam coil may be interesting and instructive to readers of *Power*.

Assume a tank 5 ft. long, 2 ft. 6 in. wide, depth of water 1 ft. 3 in., and that the temperature of the water is to be raised from 60 deg. to 200 deg. F. We will use steam at 12 lb. gage pressure.

Since one cubic foot of water weighs approximately 62.5 lb., the weight of the water to be heated is $5 \times 2\frac{1}{2} \times 1\frac{1}{4} \times 62.5 = 975$ lb. The amount of heat required to raise this weight of water to the desired temperature is $(200 - 60) \times 975 = 136{,}500$ B.t.u.

A heating coil is placed in the bottom of the tank; this coil contains 56 lin.ft. of one-inch wrought-iron pipe, and has an external heating surface of 19.3 sq.ft. To ascertain if this coil has sufficient surface to heat the water in a reasonable length of time, we refer to Marks' Handbook.

Marks gives the formula $Q = K_o A h_m$, in which Q is the heat in B.t.u. transmitted per hour, K_o the coefficient of heat transfer, A the area in square feet of heating surface, and h_m the mean temperature difference between the steam in the coil and the water to be heated.

For the value of K_o, Marks' Handbook gives $\frac{1{,}250}{\sqrt{dl}}$, d and l being respectively the diameter and length of the heating coil, both in feet. Substituting the known values of d and l in the formula, we have $K_o = \frac{1{,}250}{\sqrt{0.1095 \times 56}}$. Marks states, however, that this formula is for copper pipe and that for wrought-iron pipe the formula should be multiplied by 0.75 and again by $\frac{2}{3}$ for actual practice. The final value for K_o is, then,

$$\frac{1{,}250 \times 0.75 \times 0.66}{\sqrt{0.1095 \times 56}} = 250$$

For the value of h_m Marks gives $h_m = \frac{h_1 - h_2}{\log_e \frac{h_1}{h_2}}$, in which h_1 is the initial temperature difference; 244 (temperature of steam at 12 lb. gage pressure) $- 60 = 184$; h_2, the final temperature difference, $= 244 - 200 = 44$, and $\log_e$ = naperian logarithm $= 2.3 \times$ common logarithm.

We have, then, $h_m = \frac{184 - 44}{\log_e \frac{184}{44}} = 98$

Transposing the values of K_o, A and h_m in the formula for the transmission of heat per hour, $Q = 250 \times 19.3 \times 98 = 472{,}000$ B.t.u. This value, divided into the total heat required to raise the temperature of the water from 60 deg. F. to 200 deg. F. will give the time needed, or

$$\frac{136{,}500}{474{,}000} = 0.289 \text{ hours} = 17.3 \text{ minutes}$$

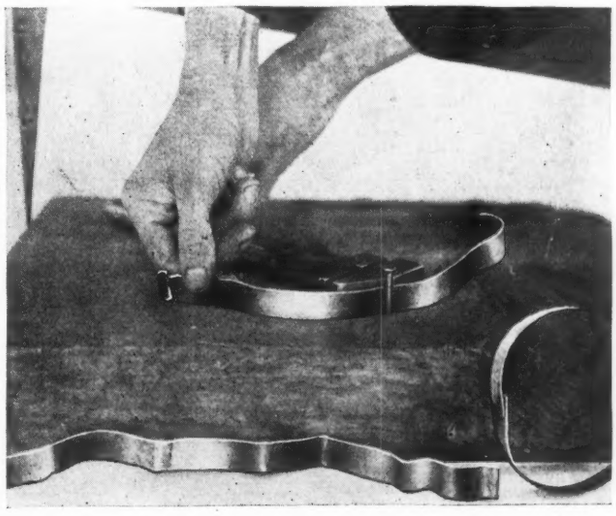
This time checked up closely with an actual installation, when the water was kept continually in motion. If the water was not agitated, the time required for heating was about one hour. A. N. P.

Newburgh, N. Y.

Simple Way to Smooth and Straighten Pipe-Covering Bands

WHEN pipe covering is taken off, and often in a hurry, the covering bands necessarily get kinked considerably. There are several ways of straightening and smoothing them out, but an easy and a quick way to do this right on the job is shown in the illustration.

Lay down a 12-in. or larger monkey wrench with the jaws closed on a spike driven well down into a block of



Band is drawn between wrench jaw and spike

wood. Drive in another spike so that moving the wrench around will pinch it on the face of the front jaw. Slip in a kinked band and move the wrench until it is lightly pinched and draw the strip through a number of times. You can quickly get the bands in excellent shape again with the tools you have at hand. F. W. BENTLEY, JR.

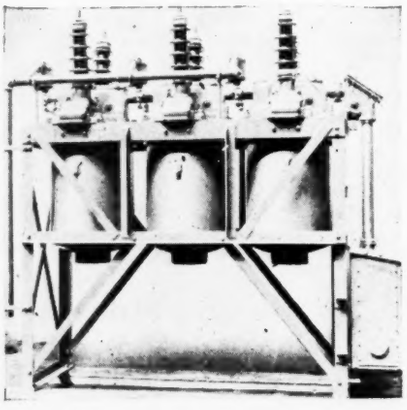
Missouri Valley, Iowa.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Oil Circuit Breaker for Heavy Duty Service

THE type 0-30 electrically operated oil circuit breaker, illustrated, is built for heavy duty service on alternating-current lines, and applicable to both indoor and outdoor



Oil circuit breaker assembly

service. It is designed for 600, 1,200 and 2,000 amperes at 15,000 and 25,000 volts.

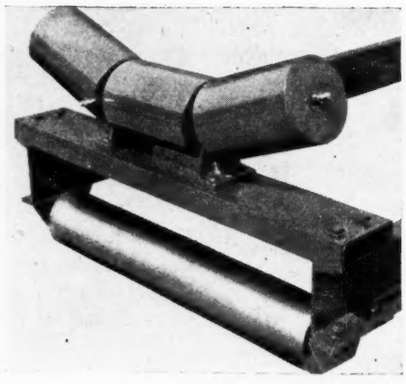
The operating mechanism may be either the direct-current solenoid or motor-operated types. The mechanism is inclosed in a weatherproof sheet-steel housing, mounted on brackets on the breaker frame. The breaker is mounted on angle-iron framework, which permits inspection and adjustment of the contacts when the tanks are lowered.

At the point where the vertical pull rods from the mechanism connect with the horizontal pull rods along the top of the breaker, a double bell-crank housing is provided. This housing has heavy partitions which separate it into two compartments; the pull rods from the operation mechanism enter one compartment, and the pull rods to the pole units enter the other. Mechanical connection is made through the divided housing by a shaft-operated bell crank which avoids the possibility of transfer of oil and gas from one pole unit to another or from pole unit to mechanical housing.

Each pole unit is equipped with a hydraulic bumper to prevent rebound. A muffler eliminates oil throw and scavenging the gases. The breaker is manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Improved Belt-Conveyor Idler

AN IMPROVED ball-bearing belt-conveyor idler in which the pulleys are spaced only one-quarter inch apart to prevent belt creasing and in which the pulleys are made from heavy steel tubing with electrically welded steel heads flush with the ends



Ball-bearing idler with unit mounting

to eliminate dust pockets, is shown in the accompanying illustration.

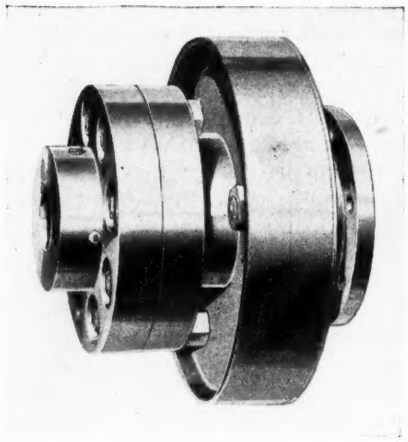
A unit mounting is used for the pulley bearings to insure correct alignment. The mounting also serves as a grease reservoir. The reservoir, it is claimed, holds sufficient lubricant for the pulley for three to six months' service, so that the attention required is reduced to a minimum. The bearings are protected from dust and grit by a quadruple labyrinth grease seal. This seal also prevents the grease from being thrown on the belt. The pulley assembly is supported by heavy cast-iron brackets suitable for mounting on either wood or channel base. It is lubricated at three points only through Alemite fittings or other types of high-pressure fittings to suit plant standards. The idler is manufactured by the Chicago Automatic Conveyor Company, Old Colony Building, Chicago, Ill.

Combination Automatic Backstop and Flexible Coupling

THE combined automatic backstop and flexible coupling illustrated is designed for use on elevators, conveyors and process equipment drives where there is a possibility of reversal of travel when the equipment is standing idle or when the motor is stopped by the operator or in case of motor failure.

The unit consists essentially of a drum-shaped housing on the back of which is integrally made one-half of a flexible coupling containing rubber bumpers fitted with oilless bronze bushings, a one-half coupling fitted with hardened and ground steel pins which float inside of the bushings, a ratchet plate, and three pawls with studs.

The backstop is applied on the drive shaft between a speed reducer



Assembly of flexible coupling and backstop

and motor. A flange attached to the speed-reducer housing is cast integral with the ratchet. This ratchet operates within the drum housing, which, in turn, is connected to the motor shaft through a flexible rubber bumper-type coupling. On the inner face of the housing are three pawls which engage with the ratchet the moment the housing stops revolving. Centrifugal force keeps the pawls out of engagement with the ratchet during

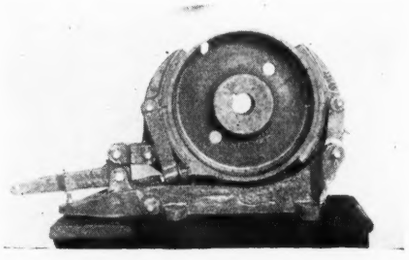
operation, but should the shaft or motor stop for any reason whatsoever, the pawls engage with the ratchet through gravity and provide a brake against reversal of travel of the driven machine.

The backstop is put out by the D. O. James Manufacturing Company, Chicago, Ill., and is available in a number of shaft sizes and horsepower capacities.

Type WB Mechanically Operated Brake

THE mechanically operated shoe-type brake illustrated is a modification of the type WB electrically operated brake manufactured by the Electric Controller & Manufacturing Company, 2700 East 79th St., Cleveland, Ohio.

The brake is designed for bridge drives of electric traveling cranes, electric hoists and other applications requiring foot-operated or hand-lever-



Brake designed for foot or hand lever operation

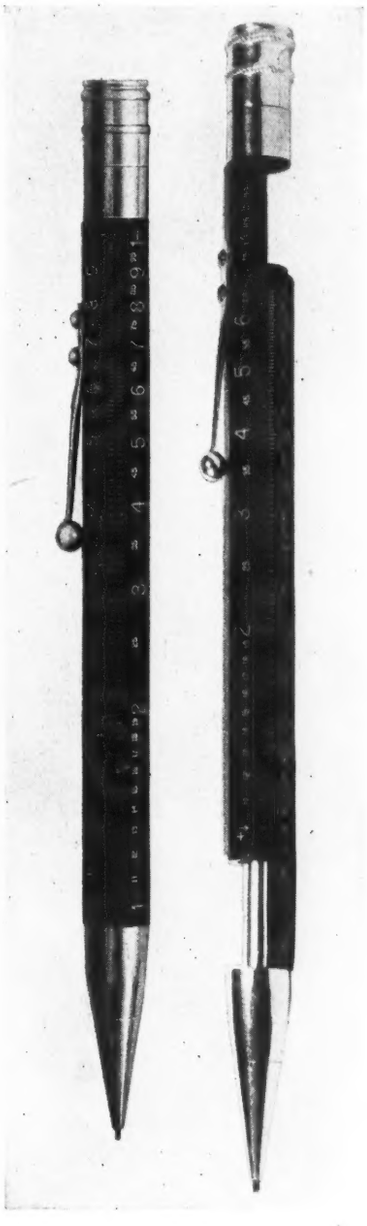
operated brakes. The brake is equipped with thick molded asbestos shoes, and all parts are interchangeable with the electrically operated brake of the WB type.

Combination Slide Rule and Automatic Pencil

THE "Multi-Vider" pencil illustrated is a combination slide rule and automatic pencil, designed for rapid calculations involving multiplication, division, percentages and proportions with sufficient accuracy for estimation purposes. The over-all length of the pencil is $6\frac{1}{2}$ in. and it measures $\frac{7}{16}$ in. across the flats of the hexagon barrel, so that it can be readily carried in the vest pocket.

The logarithmic scale is 4 in. long and is engraved by a precision machine. The hexagon barrel carries the scales, of which there are four. It is made of Bakelite for lightness and durability and is split in half. The halves slide in relation to each other as shown in the right of the view by means of a metallic strip and groove on the inside of the hollow barrel. Two pairs of scales are used, one the inverse of the other, so that it is only necessary to roll the pencil while holding it in the fingers to obtain the readings on either scale.

The outside metal parts are 14-



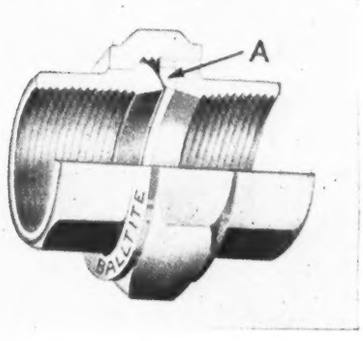
Ruxton "Multi-Vider" Pencil

karat gold filled, while the inside parts are made of spring brass nickel plated. The pencil movement is controlled by a movable sleeve at the lower end between the cone pit and the barrel. It propels the lead positively in either direction by rotation of the sleeve. The pencil is also fitted with a large eraser and with a reservoir for lead. A simplified instruction booklet is furnished with each pencil, so that those unfamiliar with the slide rule can readily learn its use It is manufactured by the Ruxton Multi-Vider Corporation, 2445 Graybar Building, New York City.

Balltite Union With Ground-Joint Metal Gasket

THE substitution of a renewable metal ball-joint gasket for the regular hand-cut washer is a feature of the new line of unions known as "Balltite," put out by the Rhode Island Fittings Company, 123 Georgia Ave., Providence, R. I.

The union is made from malleable iron with octagon pipe ends and nut. The gasket *A* is the wedge-seated ground-joint type. As the gasket is readily renewable, it obviates the necessity of regrinding the joints or



Cutaway view of union with renewable metal gasket

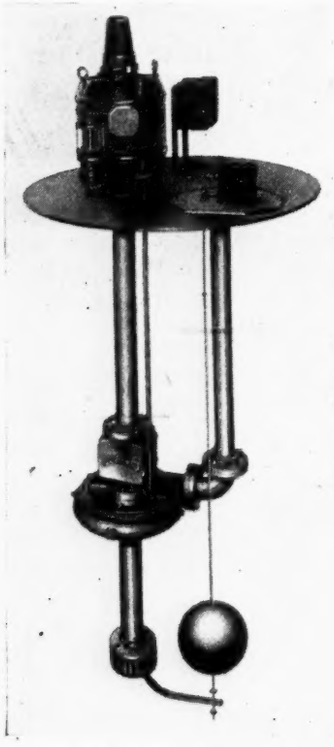
renewing the complete union when it cannot be made tight by drawing up the nut. Unions of this type are available in sizes from $\frac{3}{8}$- to 2-in. in black or galvanized.

Type M.M.D. Sump Pump

IN THE sump pump illustrated, the motor rotor and the rotating element of the pump are carried on one thrust bearing mounted in the upper end of the motor, where it is readily accessible for adjustment or replacement. The motor has a hollow shaft and the pump shaft extends up through it to the top bearing. This construction makes possible a compact unit and obviates the employment of a flexible coupling and separate thrust bearing for the pump.

The motor is mounted close to the well cover. The pump supporting pipe is bolted through to a cast-iron

plate which in turn bolts to the motor. With this construction the alignment of the pump and motor is not affected by any distortion of the pit cover.



Assembly of pump and control

The cover is made of plate steel and is furnished in the round or square.

This type M.M.D. pump, which is being put out by the American Well Works, Aurora, Ill., is assembled complete with float control switch and may be had for all standard setting up to 17 ft. in either simple or duplex units.

New Electrode for High-Speed Welding

A WELDING electrode known as "Fleet-Weld," designed to produce a dense weld of greater ductility and to increase welding speeds, is announced by the Lincoln Electric Company, Cleveland, Ohio.

The new high-speed electrode, it is claimed, gives a smoother finish to the bead than has been possible heretofore. This is due in part to the higher speed of travel obtainable and is in part inherent in the composition of the rod. It is claimed that the speed of welding is more than doubled by use of the new rod.

A comparison of the bead obtained on a butt joint of $\frac{1}{2}$ in. plate with the ordinary electrode at higher current and of the new electrode is shown by the lower and upper welds respectively in views *A* and *B*. The light area around the bead indicates the extent of oxidation, and it is pointed out that the absence of a crater in the new electrode bead is an indication of its smooth flow when in a molten state. Other advantages claimed are greater ductility of the bead and deeper penetration, an indication of the depth of penetration being shown in view *C* of the illustration.

Comparison of welds made with the ordinary electrode (lower weld, views A *and* B*) and "Flect-weld" electrode (upper weld, views* A *and* B*) and a section showing depth of penetration*

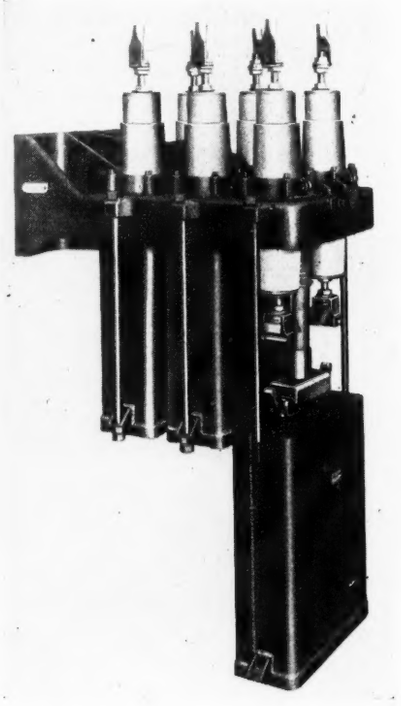
Corrosion Resisting Paint

THE Paint and Varnish Division of E. I. duPont de Nemours & Company, at Wilmington, Del., has announced production of a corrosion resistant paint consisting of an emulsion of asphalt and water. As no solvents are introduced in the manufacture of the emulsion, it is claimed that the coating produced by its use possesses all the resistance of pure asphalt.

Oil Circuit Breaker for Industrial Service

THE illustration shows type D-123 oil circuit breaker recently brought out by the Condit Electrical Manufacturing Corporation, Boston, Mass. The breaker is suitable for the control and protection of feeders in substations and industrial service.

The frame is strongly constructed with deep extending webs surrounding the tank. A tank per pole construction is used, and the tanks are of welded steel plates. The contacts are of the inverted laminated break type, designed to withstand extremely high inrush currents, and heavy arcing contacts tend to reduce the arcing on interruption.



Breaker with one tank lowered to show contacts

The breaker is available in 400-, 600-, 800- and 1,200-ampere capacities at 15,000 volts; 1,600-amperes at 7,500 volts.

Aluminum Solder

AN ALUMINUM solder known as Soldalume is announced by the Aluminum Solder Corporation of America, 730 Fifth Ave., New York City. The solder, which is a white powder, solders at 350 to 400 deg. F. and it is claimed gives a high ultimate strength of joint. It is also put out in three types of sticks, for tinning, building up, and welding.

Power Supply for New England Industry

Excerpts from paper by F. M. Gunby before New England Industries Meeting of the A.S.M.E*

NEW ENGLAND attained her industrial development through the inventive and industrial capacity of her people, and because Nature had helped her in some respects, although handicapping her in others. One of her many advantages in the early days of manufacturing was that there was an abundant supply of water power which could be easily harnessed.

As the manufacturing units grew larger, the water powers were supplemented by steam and later by purchased electricity.

Throughout this development we can see the abandonment of small factories and water powers as being no longer able to meet the increasing competition, first, from more efficient plants and later, from plants situated where some conditions made production costs lower.

From these small beginnings the power requirements have developed until it was estimated by the Power Investigating Committee of the Associated Industries of Massachusetts that the energy required for all of New England in 1928 would be in excess of 8¾ billion kilowatt-hours, not including railroad locomotives.

These statements refer to the total power, which shows a consistent increase. Individual elements, of course, vary from the average. The textile industry, and particularly the cotton portion of it, shows a decrease in power used. Some other industries have grown to offset this. Some large public-utility systems, partly by absorbing the load of others, have grown at rates far above the average, five of the larger ones showing, in the five-year period from 1922 to 1927, an average increase of about 75 per cent. The interchange of energy between companies shows a large increase for this five-year period.

Amount of Power Required

Fig. 1 shows the total energy requirements for New England, not including railroad locomotives, from 1915 to 1923, and the Committee's estimated rate of increase. The power shown here includes that for the industries, for public and domestic lighting, power for homes, and for all the miscellaneous purposes for which public-utility energy is used. It shows that for 1928 about 8¾ billion kilowatt-hours will be required, of which about 5¾ billion would be generated by central stations and about 3 billion by the industries.

*Associate, Chas. T. Main, Inc., consulting engineers, Boston.

1. The total power load of New England, excluding railroad locomotives, is increasing about 3 per cent per year.

2. The industrial load of Massachusetts is increasing 1½ per cent per year, and this figure probably holds for all New England.

3. Central station load in New England is increasing about 9 per cent per year.

4. Increased industrial load accounts for about one-seventh of the central station increase.

5. The bulk of the increase in installed motor capacity in the industries utilizes purchased power.

6. Average rates for purchased current in New England, while higher than in the Southeast, are only 5 to 10 per cent higher for single-shift work than in the Central West and Middle Atlantic States. For two-shift work the excess cost in New England is more marked.

7. What New England has lost and is losing in some lines, notably textiles and shoes, it has made up for by growth in other lines; so that the total use of power has maintained its normal rate of increase.

In 1922 about 70 per cent of the total energy was generated by fuel and 30 per cent by water, and the same proportions held for the energy generated by central stations and industrial plants. In 1927 about 75 per cent of the energy generated by the central stations was from fuel, and it is probable that the same figure would hold for the industries.

In 1927 all the public utilities and municipal plants, excluding street railways, reported a total of about 3,500,000,000 kw.-hr. on their switchboards. Of this, however, only about 2,400,000,000 kw.-hr. was generated or purchased from sources that would not be duplicated in the reports, showing that about 1,100,000,000 kw.-hr. was sold or interchanged between public utilities. This was about 2½ times the amount of energy so interchanged in 1922. During this year there was purchased from plants not a part of the public-service companies, about 40 million kilowatt-hours of electricity.

Another interesting feature is that in Massachusetts the increase of load from 1922 to 1927 for the industries only, was about 130,000,000 kw.-hr., while the increase in load of the central stations was about 930,000,000 kw.-hr. for the same period, showing that the industries used only about one-seventh of the increase in the central-station loads, the remainder probably being used for public and domestic purposes.

From 1922 to 1927 the generation by street-railway plants decreased about 10 per cent.

Power Required in Various Industries

The table shows the installed horsepower in the principal power-using industries in Massachusetts for the last several years (all figures given to nearest 100). These are arranged in order of size for 1922.

The boot and shoe industry is the only important one in Massachusetts that shows less installed horsepower capacity in 1925 than it did in 1922.

In 1922 the purchased power for all industries was about 38 per cent of the total, and in 1925 it was 43 per cent of the total, showing that purchased power accounted for much of the growth of the total power in the industries.

The fuel-burning capacity installed in the generating plants of the industries in 1925 was almost exactly the same as it was in 1914, while the water-power capacity was practically the same as it was in 1900.

Some industries require large amounts of steam for their process work, and for which fuel must be burned, whether power is generated or not. Among these are the woolen, paper, dyeing and finishing, rubber, soap making, sugar refining, laundry, and similar industries. The installed capacity in these industries in Massachusetts in 1925 was about 570,000 hp., or about 28 per cent of the total of the state's industries. The pur-

chased current represents about 28 per cent of the power uses of these industries, and this ratio has not changed much in recent years.

The remainder of the industries have about 1,440,000 hp. installed, and of this about 50 per cent in 1925 was for purchased current. The industries in this group have relatively little use for steam in their processes, the principal uses being for warming the buildings.

The proportion of purchased power in all the industries of the state has increased from 16 per cent in 1914 to 43 per cent in 1925.

Principal Power-Using Industries

The installed horsepower in the paper and wood-pulp industry of the state increased from about 139,100 to 153,200 hp., or in the neighborhood of 10 per cent. It is probable that the actual load increased in about the same proportion.

From the foregoing it appears that between 1922 and 1925 the textile industry's actual power load decreased by about 11 per cent, while in the same period the actual load of the remainder of the industries in Massachusetts increased about 15 per cent. The total actual load increased from 1,250,000 to 1,302,000 hp., which is just about the increase predicted by the Power Investigating Committee.

Data for the textile mills for 1927 show only a small decrease from 1925. The figures as to installed capacity in the other industries are not yet available.

The figures also give a clear indication that while New England's largest power-using industry has suffered severely in recent years so that the amount of power used by it has shown a substantial decrease, the growth of the other industries has been sufficient to more than offset this loss.

Costs of Purchased Power in Various Sections of the Country

In Fig. 3, the upper curves show the cost per kilowatt-hour for various loads or demands when the plant runs 200 hours per month, and assuming that the average load is 80 per cent of the demand, or, in other words, that the demand is used 160 hours per month. This would correspond to a fairly steady load, like a textile plant running one shift.

The lower curves show the cost based on using the demand 368 hours per month, corresponding to a steady load running two 55-hour shifts. The prices for all current were reduced to the basis of low-tension delivery at the industry's plant.

A considerable portion of the energy required in New England is bought and sold between power companies from day to day almost on a commodity basis.

There are certain industries that must burn large quantities of fuel to get steam for use in their processes, regardless of how their power is obtained. In this group are the wool manufacturing, dyeing and finishing of textiles, paper manufacturing, rubber industry, sugar refining, soap manufacturing, and a good deal of the chemical industry.

Where this steam can be used in the processes at low pressure, as much of it usually can be, it is simple and efficient to put high-pressure steam through a prime mover and generate power with a small portion of its heat and use the exhaust in the processes. This is common practice in most of these industries.

One important matter in the use of non-condensing turbines in connection with process steam is to avoid waste

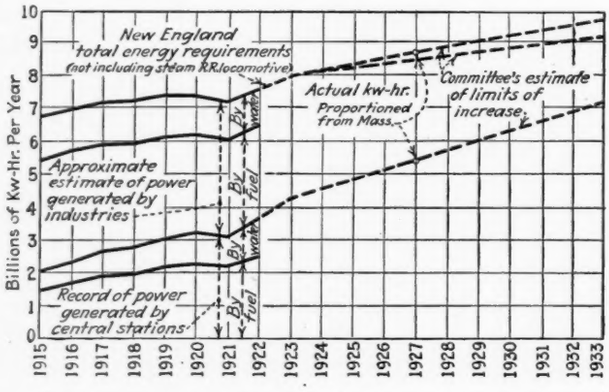


Fig. 1—Growth of New England power requirements in equivalent kilowatt-hours

Taken from report of Power Investigating Committee of The Associated Industries of Massachusetts, presented in January, 1924.

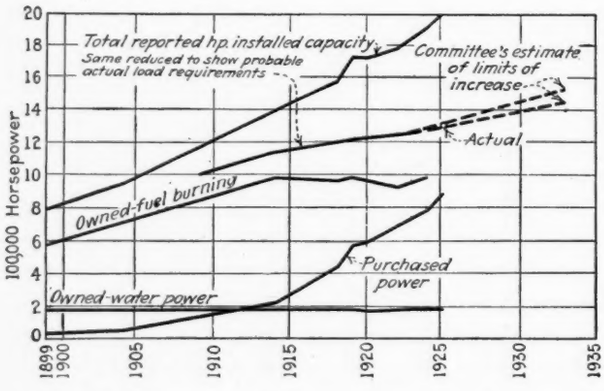


Fig. 2—Growth of power capacity—all industries in Massachusetts

Taken from report of Power Investigating Committee of The Associated Industries of Massachusetts, presented in January, 1924.

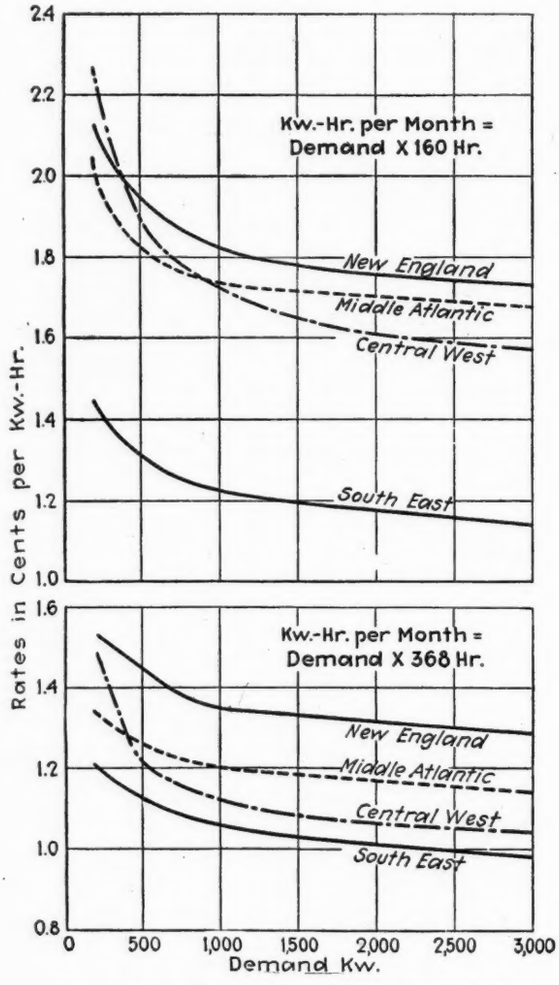


Fig. 3—Comparison of average cost per kilowatt-hour in various sections of the United States

Rates shown are averages of prices for purchased current from several important companies in each section. Rates are reduced to low-tension basis.

where the requirements for steam and power do not coincide. Where the steam requirements are far in excess of the amount produced in making power, there will be no waste.

There are many cases, however, where there is an excess of power requirement at one time of day and an excess of steam requirement at another. In cases where warm water is used in the process in large quantity, it has been possible to balance these conditions by making and storing warm water.

It would seem that these cases should give grounds for the power companies to come in and act as the balance wheel and sell all the kilowatt-hours the industry did not make from its steam needs. Special rates would generally be desirable, probably working on a buy-and-sell arrangement. There is about a half-million horsepower in industries having these conditions, and in this field the rate of growth of purchased current is small and may be expected to remain so unless some such arrangement as indicated can be worked out.

There are now cases of waste where, because an industry cannot afford not to generate some of its power with process steam, it is forced to generate it all, and at times to waste steam. It would seem that there should be some solution that would meet these cases and permit the power companies and the industries to share what must now be wasted. In the case of industries using, say, less than 500 kw., there will probably not be sufficient savings possible to justify doing anything special.

In general, plants served by long transmission lines are subject to more frequent interruptions and annoyance than those with good installations of their own. On the other hand, there is less likelihood of a long shut down, due to accident, when served by a modern, well-managed utility than where the industry has its own plant and does not have sufficient spare capacity.

INDUSTRIAL HORSEPOWER

Industry	1909	1914	1919	1922	1925
Cotton goods (incl. smallwares)	362,000	438,100	526,400	536,500	572,200
Woolen and worsted goods (incl. felts)	127,200	154,100	190,100	199,000	230,000
Paper and wood pulp	115,800	133,900	145,300	139,100	153,200
Iron and steel works, foundry and machineshop products	.....	.....	.....	*100,000	*133,000
Dyeing and finishing textiles	.....	30,900	39,100	53,000	72,300
Boots and shoes (incl. cut stock and findings)	.....	39,700	48,400	50,700	43,700
Rubber goods	.....	17,500	34,400	43,000	62,000
Electric machinery, apparatus and supplies	.....	29,900	36,400	40,000	57,500
Leather, tanned, curried, and finished	.....	26,300	34,200	37,900	40,500
Cordage, twine and jute goods	.....	28,600	32,400	33,000	.....
Wire and wire working	.....	15,100	24,800	23,900	31,400
Gas	.....	11,500	18,800	22,200	25,700
Printing and publishing	.....	.....	21,100	20,500	24,200
Cutlery and misc. tools	.....	.....	20,900	19,900	.....
		925,800	1,172,300	1,318,700	1,445,700
Miscellaneous other industries	.....	471,000	557,200	471,400	567,300
Total	1,175,100	1,396,800	1,729,500	1,790,100	2,013,000

*These figures are probably not strictly comparable.
NOTE—The total for 1926 was 2,016,000 hp.

RECENT PUBLICATIONS

MECHANICAL POWER TRANSMISSION. By William Staniar, Mechanical Power Engineer, du Pont de Nemours & Co. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York City. 1928. Cloth; 6x9 in.; 58 tables; 326 illustrations; 409 pages. Price $5.

MECHANICAL power transmission before the electrical age played an outstanding part in applying machinery to industry. Then electric generation, transmission and application came into being, affording many possibilities of extending power into industrial manufacturing processes. The absence of belts, gearing and other mechanical devices with direct-connected motors, created a general idea that mechanical power-transmission equipment would eventually disappear from the power pictures. This, however, has proved to have been a wrong conception, and economic laws have asserted themselves in a way that shows that mechanical power-transmission equipment still has a prominent place in the economic application of power.

One of the strongest arguments in favor of the latter position is this volume by a leading mechanical engineer with one of the largest manufacturing companies in America. This book is not one on theory, but is practical, and the result of twelve years devoted to analyzing, testing and applying modern power driving methods in the plants of the company with which the author is connected.

The book has been written with the object in mind to make readily available information on mechanical power applications, for those who are responsible for their use and operation. All mathematics has been omitted except simple application formulas. Wherever possible the data have been presented in tables, as is indicated by the 58 tables included.

There are 25 chapters, each treating some phase of mechanical power-transmission equipment, such as belting, which has nine chapters devoted to it; pulley; shafting; bearing; rope transmission; chain drives; gear reduction; variable-speed mechanism, and other devices. For those who have mechanical-transmission problems this book provides the means to a better understanding of these applications and greater economy in applying power in industry.

CONSTRUCTION OF ALIGNMENT CHARTS. By Geo. W. Swett, S.B., Associate Professor of Machine Design, M.I.T. Published by John Wiley & Sons, Inc., New York City, 1928. Cloth; 6x8 in.; 89 pages; 47 illustrations. Price, $2 net.

THIS book will meet the needs of the designer or engineer who could make practical use of the ability to construct alignment charts, but cannot afford the time or effort to wade through longer and more mathematical treatises. Mathematics is not absent, of course, but it is of a simple sort, never going beyond elementary trigonometry. One chapter is devoted to conversion scales. Another takes up equations of three variables (parallel scales). The fourth shows how equations of more than three variables are handled by parallel scales or by Z charts. The final chapter deals with miscellaneous forms needed to handle special cases.

BITUMINOUS COAL FIELDS OF PENNSYLVANIA. Introductory Volume, Part I, General Information on Coal. By Geo. H. Ashley. Topographic and Geologic Survey Bulletin M-6, Part I. Published by the Bureau of Publication, Department of Property and Supplies for the Commonwealth of Pennsylvania. Paper; 5½x9 in.; 241 pages. Price, 50 cents.

THIS is Part I of a series of projected volumes on the coal fields of Pennsylvania. Three other volumes will deal with a description of coal fields, the coal resources of Pennsylvania and an analysis of Pennsylvania bituminous coal. This introductory volume deals with general information on coal, its character, origin and classification, and includes brief descriptions of bituminous coal beds and of the bituminous coal fields of Pennsylvania. It also contains some information on the mining of coal in this state.

THE MOST EFFICIENT DRIVE IN INDUSTRY is the title of a 56-page book recently published by the Electric Machinery Manufacturing Company, Minneapolis, Minn. This book is not a catalog, but consists of a number of articles dealing with the operation and application of synchronous motors. Among these articles is one that explains, in a practical way, how a synchronous motor operates. Another article deals with the characteristics of modern synchronous motors and covers such subjects as starting and pull-in torque, pull-out torque, starting current and automatic control. Applications of synchronous motors to driving industrial machinery form an important part of the subject matter. Those interested in motor applications will find this book of interest and value.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Practical Refrigerating Engineers Meet in Louisville, Ky.

Five hundred delegates hear many papers on plant methods and economies—Educational program discussed.

THE Nineteenth Annual Convention of the National Association of Practical Refrigerating Engineers opened at the Jefferson Armory, Louisville, Ky., on Nov. 19. The initial meeting, attended by close to 500 members, was featured by an address of welcome by Mayor William B. Harrison and by the address of the organization's president, Fred I. McCandlish. The latter pointed out that the ice business was the seventh in point of gross receipts, and he characterized the engineering organization as a clearing house of information whereby the individual ice manufacturers could reduce operating costs. The remainder of this session was devoted to the presentation of committee reports on the various organization activities.

The other meetings during the week were devoted to a number of papers and to the discussion of various questions deposited in the Question Box.

As the majority of ice plants are electrified, a large audience listened to Jay R. Watson discuss "Repairs and Maintenance of Electrical Machinery," which was presented at the Tuesday afternoon session. In this paper particular attention was given to electrical machines used in ice plants. The paper will be published in a later issue of *Power*. Another paper, "Cooling Water Problems," by R. P. Mose and E. L. Barnhart, outlined methods of piping, handling and cooling of condenser water.

Leslie C. Smith, of the National Association of Ice Industries, in a talk on "Contact Between the Engineer and Employee," stressed the point that in ice manufacturing the employer's profit depends upon the zeal and loyalty of the engineer. The entire ice-making process is under the engineer's direct charge, and in fact he is often the only one in the plant who can make ice. The speaker expressed the hope that the engineer's endeavor to educate himself would be appreciated more fully by the employer. Mr. Smith expected that the sale of household ice machines would continue to increase and felt that the ice manufacturers must look for their market among those who at present use no ice, these amounting to 46 per cent of the population. The fates of the refrigerating engineer and the ice manufacturer are bound together, he pointed out, and it behooves the engineer to find ways and means of reducing operating costs.

On Tuesday evening the organization held its Chapter Dinner, at which the various chapter delegates outlined the operation of the educational program. The general tenor was that it was impossible to induce the older members to take part in the lectures along with the less experienced younger members. Many of the older men were unwilling to confess that they did not grasp all the principles of refrigeration. As the organization's chief aim was to educate its members, the present lack of success of the lecture course was a matter of grave concern. The first step was to impress on the members the fact that no one, no matter how able he is, can be expected to know the whole subject.

On Wednesday morning Charles B. Conley discussed "Cold Storage Operation," giving special attention to the matter of obtaining the correct humidity by the use of water sprays. A number of members were inclined to dispute the possibility of obtaining a desirable humidity by water sprays or any other method other than through air conditioning.

"Packing House Refrigeration" was the title of a paper by O. A. Anderson. The author dealt with the problem of chilling fresh killed meat. The development of the refrigerating method from the daily overhead brine deck to the present system of using air ducts into which chilled brine is sprayed was illustrated by a set of lantern slides. This was the most interesting of all the papers, although the author did not discuss the possibility of the direct brine-contact method now used in fish freezing. The paper will appear in full in a future issue of *Power*.

C. A. Anderson, of New Orleans, in a paper entitled "Defrosting Brine Coils," discussed the method of defrosting he had developed in his plant. A tank of brine was kept outside of the building at atmospheric temperature. When a set of coils was to be defrosted, the brine was pumped through the particular set of coils and as it was above the room temperature, it melted the frost.

At noon Wednesday, the Henry Vogt Machine Company was the luncheon host to the delegates, after an inspection trip had been made through the shop of this company. The delegates were especially interested in the manufacturing of the Vogt drop-forged fittings. In the afternoon a visit was made to the Ohio Falls hydro-electric plant of the Louisville Gas & Electric Company, where eight 13,520-kva. vertical Allis-Chalmers waterwheels are driving General Electric alternators. The entire plant is operated by push-button control from a central supervising desk, by one man.

The annual banquet was held on Wednesday evening. Always the outstanding feature of the convention, this banquet drew many others besides the delegates. The entertainment was more than high grade, and was without that cheap vaudeville atmosphere which mars so many banquet entertainments.

Tom Shipley, as the president of the York Ice Machine Corporation and well known among refrigerating engineers, can always be depended upon to reveal some interesting information. For this reason the Thursday morning session was packed by listeners to his paper on "Recent Developments in Evaporating Systems." It is difficult to abstract this, and it will be published in a later issue.

At the Thursday afternoon session, W. E. Bernd discussed "Practical Plant Operation." In this paper he outlined how a plant should be operated to obtain the greatest possible efficiency.

A feature that aroused interest was "Televox," the Westinghouse electrical-mechanical man. While the stunts it performed were startling, it must be confessed that the machine fell far short of what the publicity in the daily papers had led the audience to expect. The machine seemed hardly to justify the term Mr. Televox.

Friday morning, W. H. Motz pre-

In the News

This is the open season for conventions. Everywhere engineers are preparing for symposiums in which new knowledge will come to light. But it is not so much the technical advances that are significant as it is the spirit of sharing that knowledge. Cooperation which ignores competition may lift a convention from a mere cataloging of data to a place on the pages of engineering history.

sented a paper on "Modern Evaporating Systems," in which he outlined developments up to the present time, with emphasis on the Hilger evaporator. The evaporators are made up of sets of coils so connected that the pressure heads in all the coils are approximately the same, and was operated with a control valve that was assumed to shut off the liquid feed when a slopover occurs, a thing Thomas Shipley says is impossible.

"A new Type of Condenser" was the subject of a paper by B. F. Kubaugh, of the Henry Vogt Machine Corporation. This condenser follows the design developed by the Vogt engineers, in which a large pipe is provided with heads into which is expanded a nest of smaller tubes. A condenser is made up of a number of these units placed in parallel.

On Saturday many of the delegates attended the races at Churchill Downs, while some made a bus trip to Mammoth Cave, as did others on Sunday.

F. B. Fulsner, Oakland, Calif., was elected president for 1929, and George H. Pardee, Louisville, vice-president.

A.S.R.E. Convention Opens December 5

Twenty-fourth annual meeting of technical refrigerating men to cover all classes of cooling problems—Dr. Davis of Stevens will address banquet

THE American Society of Refrigerating Engineers will hold its twenty-fourth annual convention at the Hotel Pennsylvania, New York City, Dec. 5 to 8. Final plans for the technical sessions and entertainments have just been announced. A feature of the convention will be the joint session with the A.S.M.E. on Friday morning, Dec. 7. A "bigger and better event" is promised by the program committee, which points out that the society has doubled in membership in the last eighteen months. The scope of the sessions is broad, covering large and small refrigerating machinery and their applications.

Among the numerous subjects to be presented, the following will receive particular attention: Oil refinery refrigeration, ammonia condenser tests, air conditioning, dry ice machinery, arc welding, dairy refrigeration, rural refrigeration, flake ice manufacture, silica gel for freight cars, electric refrigeration load tests, use of fins on condensers, heat flow in refrigerators, heat transmission problems, refrigerator test methods, finishing refrigerators, shaft seals, and effect of weather on electric refrigeration.

An inspection trip has been arranged for Thursday afternoon, to the U. S. Navy Yard at Brooklyn, where the members will examine the refrigerating equipment installed on the U.S.S. "Bridge," a supply ship of the Navy. The entertainment program will also include the annual dinner-dance on Friday evening, the principal feature of which will be a talk by Dr. Harvey N. Davis, recently elected president of the Stevens Institute of Technology.

The new McGraw-Hill Building on North Michigan Avenue, Chicago, as it will look when completed in the spring of 1929

A.S.M.E. Annual Dinner to Have Noted Speakers

The annual dinner which the mechanical engineers will hold in connection with their convention this week will be addressed by several noted speakers. The dinner will be held on the evening of Dec. 5, at the Hotel Astor ballroom.

Under the toastmastership of Paul Doty, manager of the society, the members will hear Elmer Sperry, president-elect, Alex Dow, retiring president, and Charles M. Schwab, a former leader of the society. The principal speaker of the evening will be Dr. E. E. Free.

Johns-Manville Acquires Celite Products Co.

Purchase by the Johns-Manville Corporation of the assets and the entire line of products of the Celite Products Company has been completed, as has been announced in financial circles. This acquisition enables Johns-Manville to take another important step in the strengthening of its position in the field of insulation and allied materials.

Accordingly, the Celite Products Company now brings to Johns-Manville an annual business of over $4,000,000, in net sales of high temperature insulation and kindred lines, made from diatomaceous earth—a fossilized deposit derived from ancient sea life. An even more valuable asset, however, is the Celite holdings of this deposit in California, which is one of the largest known sources of this kind and quality.

In addition to insulating products, the Celite Products Company has been a large producer of filtration materials extensively used in sugar mills, oil refineries, sewage disposal plants, etc. Celite for concrete, one of the newer uses of Celite, is already one of the largest developments of this product.

H. N. Davis Advocates General Curriculum in Stevens Inaugural

Believes students better equipped when not specializing—All engineers need same foundation

BEFORE the most notable gathering that has convened in many years at a college inaugural function, Dr. Harvey N. Davis on Nov. 23 assumed the presidential chair of Stevens Institute of Technology, at Hoboken, N. J. The keynote of his inaugural address was in line with the modern theory of generalization in undergraduate engineering studies. The new president declared for "one fundamental, unspecialized curriculum in engineering" that would ground the students in the essentials of all engineering, teach them to think and "to begin to learn," round them out with a broader foundation of culture, and prepare them for post-graduate specialization, professional proficiency and satisfactory human relationships.

"Such preparation," he said, "would raise engineering education from the status of the trade school, with its multiplicity of special apprenticeship courses, to the status of the training schools of the older professions of law and medicine."

Discussing the value which a newly graduated engineer may represent to his first employer, Doctor Davis said:

"Why waste time in an engineering school learning details, descriptions of processes and of machines, tricks of technique of hand or brain, or even miscellaneous facts, all of which, so far as one wants them at all, can be learned far more effectively on the job. Why not devote one's time in the school to learning what one may never have another chance to learn, namely, fundamental principles, and how to think. And always remember that ignorance, plus willingness to learn, plus *ability* to learn, is a far better basis on which to establish appropriate and satisfactory human relationships with one's own organization, and with the world in general, than is 'knowing a lot of things, even if *all* of them *are* so.'

"There will be only one, unspecialized undergraduate curriculum rather than seven or seventeen or forty-three specialized ones, and the one curriculum will prepare in one sense for all sorts of engineering careers, and in another sense for no career whatever. That is, it will not attempt to teach the detail of any branch of engineering, but it will attempt to turn out young men who are well prepared to *begin to learn* the detail of any one of many branches. Its graduates won't know much, but they will have the saving grace of knowing that they don't know much, and of knowing what to do about it. If any of them fall into the hands of a captain of industry, no positions whatever will be closed to them, for wherever he puts them, they will carry with them an ample abundance of the black soil of ignorance in which to raise the flower of eager self-education which he so much desires."

Dr. Harvey N. Davis

On the eve of the inauguration the alumni association of the Institute held its annual dinner, at which President Faunce of Brown University was the principal speaker. Preceding the ceremonies on Nov. 23 a technical session was held on the campus, at which Dr. R. A. Millikan, director of the Norman Bridge Laboratory of the California Institute of Technology, discussed certain phases of research on electrons. A formal academic procession took place before the inauguration, in which representatives from 94 colleges and universities, among them 32 college presidents, took part. One of the principal speeches at the ceremony was delivered by President A. Lawrence Lowell of Harvard University, in which he advocated that more attention be paid to research by professors and students alike.

An interesting feature of the program was the operation of a replica of the original Stevens locomotive, which circled about a track placed upon the Institute campus, propelling itself with the aid of a rack and pinion arrangement. This engine dates back to 1825, and was the first designed in America.

Report Shows Status of Maine Water Power

The biennial report of M. R. Stackpole, engineer in charge of the water resources division of the Maine Public Utilities Commission, which has just been filed with the Governor and Council, states that the present capacity of waterwheels in that state is 549,747 hp. This figure represents an increase of 206,651 hp. over the capacity in 1908, when a water-power census was taken in Maine by the United States Geological Survey.

The present ownership is divided as follows, notes Mr. Stackpole in his report: public utilities, 239,554 hp.; paper companies, 223,696 hp.; industrials and others, 86,497 hp.

"These figures represent the total capacity of the waterwheels installed," said Mr. Stackpole. "Primary power is commonly figured on the basis of river flow available 90 per cent of the time, while secondary power is sometimes figured on the basis of river flow available 50 per cent of the time.

"The estimate of total potential power in Maine, according to the United States Geological Survey, is 1,074,000 hp. 50 per cent of the time, and 536,000 hp. 90 per cent of the time. These figures show the 24-hour power available at both developed and undeveloped sites.

"The percentage of the total potential water power of Maine that has already been developed can be estimated in an approximate way. Studies show that at the developed sites the installed waterwheel capacity is 131 per cent of the power available 50 per cent of the time. Assuming that all sites may be developed eventually to a point where the wheel capacity is 131 per cent of the power available 50 per cent of the time, we may say that the installed capacity will reach 1,406,940 hp. On the above assumption of the ultimate installed capacity, about 39.1 per cent of the potential water power of Maine has now been developed."

Coming Conventions

American Institute of Electrical Engineers, annual winter convention, New York City, Jan. 28-Feb. 1; annual summer convention, Swampscott, Mass., June 24-28; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Oil Burner Association, annual convention, Hotel Pennsylvania, New York City, April 9-11, 1929. For information, address the headquarters of the Association at 420 Madison Ave., New York City.

American Society of Heating and Ventilating Engineers, 35th annual meeting, Chicago, Ill., Jan. 28-31, 1929. A. V. Hutchinson, secretary, 29 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Engineering Institute of Canada, annual general and professional meeting, at Hamilton, Ont., Feb. 13-15, 1929. R. J. Durley, secretary, 2050 Mansfield St., Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; G. E. Pfisterer, secretary, 53 West Jackson Blvd., Chicago.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

Obituary

Dr. Frank Casper Wagner, president of Rose Polytechnic Institute, Terre Haute, Ind., was killed Nov. 21, when an automobile in which he was riding was struck by a street car. Doctor Wagner was born at Ann Arbor, Mich., on Oct. 5, 1864. He attended the University of Michigan and received the degrees of Master of Arts and Bachelor of Science from that institution. He served as assistant professor of mechanical engineering at the University of Michigan from 1890 to 1896, associate professor of steam engineering from 1896 to 1904 and professor of steam, electric and mechanical engineering from 1904 to 1923. Since that time he has been president of the Rose Institute.

Personals

O. P. Adams, of the Florida Power & Light Company, is leaving that company to take charge of a power plant of the National Tube Company, at McKeesport, Pennsylvania.

R. J. S. Pigott, formerly consulting mechanical engineer of the Public Service Electric & Gas Company of New Jersey, has resigned this position and has become associated with the Smoot Engineering Corporation, of New York City.

Prof. R. E. Clark, of the Heat Power Engineering Department of Sibley College, Cornell University, spent several months recently with the General Electric Company at Schenectady, N. Y., where he assisted in the compilation of a set of new steam charts which carry the temperature range up to 1,000 deg. F., and the pressure up to 3,500 lb.

T. P. Walker, vice-president of Virginia Electric & Power Company, is to be transferred from Norfolk to Richmond, and starting on Dec. 1, was placed in charge of all operations of the company, succeeding J. F. McLaughlin in these positions.

Stanley M. Mercier has recently been appointed manager of the Boston, Mass., office of the Jeffrey Manufacturing Company, Columbus, Ohio.

A. W. Bollenback has resigned his position as assistant mechanical engineer of McClellan & Junkersfeld, Inc., New York City, as of Nov. 15 and has become associated with the condenser department of the Ingersoll-Rand Company in its New York office.

Charles H. Bromley, formerly of the staff of *Power*, and subsequently with the S. F. Bowser Company, and lately general manager of the France Packing Company, is now associated with the Pine Oil Company, and is temporarily located in Pittsburgh, Pa.

With the Society Sections

American Engineering Council, annual meeting, to be held in Washington, D. C., Jan. 14-15, 1929, at the Mayflower Hotel.

A. S. M. E., Midcontinent Section. Joint meeting, Dec. 8, with the Little Rock Engineers, at Little Rock, Ark. Subject: Function of the A. S. M. E. in the Mid-Continent section, by H. P. Porter.

A. S. M. E., Syracuse Section. Meeting Dec. 17, at the Onandaga Hotel. Subject: Lubrication, by R. P. Tobin, chief engineer of the Vacuum Oil Company.

A. S. M. E., Hartford Section. Meeting at the Hartford Electric Light Company's auditorium Dec. 18. Subject: Opportunities for Public Service Usefulness, by Samuel Ferguson, president, Hartford Electric Light Company.

A. S. H. & V. E. Council. Meeting in New York City, Dec. 6, at 29 W. 39th St. At this meeting the program of the annual meeting will be discussed.

American Water Works Association, New York Section. Meeting, Dec. 28, at the Hotel Pennsylvania. This will be a luncheon meeting.

American Water Works Association, Kentucky-Tennessee Section. Annual meeting, to be held at Chattanooga, Tenn., Jan. 24-26, 1929.

National Marine Engineers Benefit Association. The 54th annual meeting will be held in Washington, D. C., Feb. 11-16, at the Hotel Hamilton.

Providence Engineering Society, Power Section. Meeting, Dec. 13. Subject: "Out of the Darkness" (Scientific treatment of water to prevent scale and corrosion), by Dr. R. E. Hall.

Business Notes

The Reading Iron Company announces the appointment of P. N. Guthrie, Jr., as vice-president, and at the same time announces that the general sales offices of the company will be transferred from Reading, Pa., to 30 Church St., New York City. Mr. Guthrie will have charge of sales and H. F. Mattern will continue as general sales manager.

The Prest-O-Lite Company, Inc., of New York City announces the opening of a new acetylene plant at East Avenue and Short Street, South Charleston, W. Va., bringing the total number of Prest-O-Lite plants throughout the country up to 35. The new plant started producing Oct. 29th, and will supply dissolved acetylene for welding and cutting purposes.

Trade Catalogs

Speed Reducers—In a four-page leaflet just issued, the Palmer-Bee Company, Detroit, Mich., illustrates its new herringbone speed reducer, showing several photographs of the reducer with cover removed. Two pages of text also describe the product in some detail.

Water Softeners — The International Filter Company, of Chicago, Ill., has issued a sixteen-page bulletin, describing its line of "Crystallite" water softeners, adapted to many uses. The bulletin contains chemical information and other data of interest.

Curve-Drawing Instruments—In four-page bulletin No. 1128, the Esterline Angus Company, of Indianapolis, Ind., pictures and describes recent improvements in its line of graphic instruments.

Chains and Sprockets—The Webster Manufacturing Company, Chicago, Ill., has just issued catalog No. 50, descriptive of its line of chains and sprockets for many uses. The catalog contains 96 pages of general information, many illustrations and numerous tables of sizes and prices.

D-C Motors — "Type CD" electric motors are treated in a four-page bulletin No. GEA-61B issued by the General Electric Company, Schenectady, N. Y. This bulletin is in the usual style of the company and gives numerous photographs of this line of direct-current motors, built in sizes from three to 500 hp.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.35@$2.60
Kanawha	Columbus	1.35@ 1.75
Smokeless	Cincinnati	2.25
Smokeless	Chicago	2.25
S. E. Kentucky	Chicago	1.35@ 1.60
Steam	Pittsburgh	1.65@ 1.80
Gas Slack	Pittsburgh	1.00@ 1.20
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75@$3.00
Barley	New York	1.25@ 1.75

FUEL OIL

New York—Nov. 22, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4¾c. per gal.; 36@40 deg., furnace, tank-car lots, 6½c. per gal.

St. Louis—Nov. 7, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.3709 per bbl. or 42 gal.; 26@28 deg., $1.4209 per bbl.; 28@30 deg., $1.4709 per bbl.; 30@32 deg., $1.5209 per bbl.; 32@36 deg., gas oil, 4.151c. per gal.; 38@40 deg., 5.105c. per gal.

Pittsburgh—Nov. 13, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5½c. per gal.

Philadelphia—Nov. 17, 13@19 deg., $0.95@$1.02 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 26@30 deg., $2.00@$2.06 per bbl.

Cincinnati—Nov. 20, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Nov. 17, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 97½c.@$1 per bbl.

Boston—Nov. 19, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.55c. per gal.; 28@32 deg., 5.6c. per gal.

Dallas—Nov. 17, f.o.b. local refinery, 26@30 deg., $1.20 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Lonoke—Waterworks Improvement Dist. No. 1, c/o W. P. Fletcher, Jr., will soon award contract for waterworks improvements including well, pumping station, tank on tower, etc. W. Terry Field, 338 Gazette Bldg., Little Rock, is engineer.

Mass., Brockton—Brockton Edison Electric Illuminating Co., A. F. Nelson, Mgr., 42 Main St., is receiving bids for the construction of a sub-station on Riverview St. Estimated cost $75,000. C. S. Mason, 42 Main St., is company engineer.

Mass., Roxbury (Boston P. O.)—Boston Elevated Railway Co., 31 St. James Ave., Boston, is receiving bids for the construction of a boiler house, also repair and service garage, etc., at Bartlett and Washington Sts., here. Estimated cost $75,000 to $100,000. A. J. Blackburn, 31 James Ave., Boston, is company architect.

Mass., South Boston (Boston P.O.) — Commonwealth Ice & Cold Storage Co., Fish Pier, awarded contract for the construction of a cold storage plant to W. T. Reed Co., 201 Deveonshire St., Boston. Estimated cost $50,000.

Mich., Dearborn—Dearborn City and Detroit, are having plans prepared for the construction of a sewage disposal plant, including pumping station, etc., at River Rouge, south of Michigan Ave. Estimated cost $185,000. P. A. Fellows, City Hall, Detroit, is engineer.

Mo., Luxemburg (St. Louis P. O.) — Titanium Pigment Co., 1 Sidney St., St. Louis, awarded contract for the construction of a 70 x 80 ft. power house to Fruin-Colnon Construction Co., Merchants-Laclede Bldg., St. Louis. Estimated cost $40,000.

Mo., University City—Bd. of Education, c/o A. Fairbank, Pres., will receive bids until Dec. 11 for first unit of high school including boiler house, etc. at Jackson Rd. and Dorsett and Shaftsbury Sts. Estimated cost $550,000. Total cost $1,000,000.

Mont., Great Falls—Montana Power Co., subsidiary of American Power & Light Co., 71 Broadway, New York, N. Y., plans the construction of a hydro-electric plant, 70,000 hp. capacity near here. Estimated cost $4,000,000. Engineering Dept. of Electric Bond & Share Co., 2 Rector St., New York, in charge. Work will probably be done by separate contracts.

N. Y., Brooklyn—Kingsway Hospital Constructors Inc., 50 Court St., are having plans prepared for the construction of a hospital including mechanical refrigeration plant, etc. at Kings Highway, East 26th St. and Ave. O. Estimated cost $1,000,000. S. Malkind, 93 Court St., is architect.

Ohio and Kentucky—City Ice & Fuel Co., E. C. Balzhizer, V. Pres., 6611 Euclid Ave., Cleveland, is having plans prepared for the construction of ice plants at Westwood and Hilltop, O., also at Fort Thomas, Ky. Estimated cost $75,000, $75,000 and $60,000 respectively. W. A. Schmid, 3220 Jefferson Ave., is engineer.

O., Cleveland—Dept. of Public Welfare, J. E. Harper, Dir., will receive bids until Dec. 26 for the construction of a cold storage plant at Cleveland State Hospital. Estimated cost $125,000. H. B. Briggs, Ohio-Hartman Bldg., is engineer.

O., Willoughby — City Ice & Fuel Co., Balzhizer, V. Pres., 6611 Euclid Ave., Cleveland, awarded contract for the construction of a 100 x 100 ft. ice plant, here, to Reaugh Construction Co., Engineers Bank Bldg., Cleveland. Estimated cost $90,000.

Va., Luray — Page River Power Co., awarded contract for adding four ft. to height of hydro-electric dam on Shenandoah River, four miles west of Luray, to increase capacity from 1,400 to 1,875 hp., also extending power lines to many places along Blue Ridge mountain ranges to W. C. Whitner Co., Electric Bldg., Richmond.

Va., Norfolk—Jones Cold Storage & Terminal Corp., A. P. Jones, Pres., is having preliminary plans prepared for the construction of a 90 x 120 ft. cold storage warehouse including freezers, coolers, ventilating machines, etc.

B. C., Essondale—Provincial Government, Victoria, awarded contract for the construction of a hospital including power plant here to Pacific Engineers Ltd, 827 Powell St., Vancouver, B. C. Estimated cost $1,452,996.

Man., Winnipeg—City plans the construction of a hydro-electric development including additional power units, etc. at Slave Falls on the Winnipeg River. Estimated cost $6,500,000.

N. S., Halifax—Canadian National Railways, Montreal, Que., plans the construction of cold storage terminals, here. C. S. Gzowski, is chief engineer.

Equipment Wanted

Air Compressor, Motor Etc.—W. Bartel, 170 Virginia Rd., Concord, Mass., is in the market for an air compressor, gasoline motor, etc.

Air Ejector, Cooler, Condenser, Etc.—Bd. of Purchases, H. C. Cain, Secy., City Hall, Columbus, O., will receive bids until Dec. 13 for one twin air ejector with inner cooler and outer condenser for light plant.

Boiler and Stoker—City of Galion, O., will soon receive bids for a 500 hp. boiler and mechanical stoker for proposed addition to power plant. Estimated cost $40,000.

Boilers—Bd. of Trustees, Wittenberg College, Springfield, O., is in the market for two 150 hp. tubular boilers for power plant.

Engines, Air Compressors — Supt. of Lighthouses, Charleston, S. C., will receive bids until Dec. 18 for two 82 to 85 hp. full Diesel marine propelling engines, one 3 hp. electric motor driven air compressor with accessories for Lighthouse Tender, Palmetto.

Ice Machine and Equipment—Continental Ice Co., 7744 Jeffery Ave., Chicago, Ill., is in the market for an ice machine and equipment for proposed ice plant at Port Huron, Mich. Estimated cost $200,000.

Pump—City of Hastings, Mich., electrically driven centrifugal pump for proposed sewage disposal plant.

Pump, Etc.—City of Billings, Mo., plans the installation of a booster pump, etc. for proposed waterworks system. Estimated cost $35,000.

Pump and Power Unit—City of Camp Perry, O., F. D. Henderson, will receive bids until Dec. 10 for the installation of a pump and power unit for Waterworks Department. Estimated cost $25,000.

Pump, Motor, etc.—Hillview Drainage & Levee Dist., White Hall, Ill., will receive bids until Dec. 6 for pump, motor, etc., at main pumping station.

Pumping Equipment—People's Light & Power Co., 27 William St., New York, N. Y., pumping equipment, etc., for proposed improvements to waterworks plant at Weimar, Tex. Estimated cost $1,000,000. R. L. Anderson, Weimar, local representative.

Pumping Equipment, Motors, Stokers, Etc.—Minnesota Valley Canning Co., Montgomery, Minn., will receive bids early in December for deep well pumping equipment, motors, mechanical transmission lines, stokers, smoke stack, etc. in connection with new canning plant. Estimated cost $90,000.

Pumping Unit, Etc.—City of Port Neches, Tex., will receive bids after Dec. 1 for pumping unit, etc. for proposed waterworks. Estimated cost $70,000.

Pumps, Motors, Transformers, Etc.—Dept. of Public Works, G. F. Fisk, Comr., Municipal Bldg., Buffalo, N. Y., will receive bids until Dec. 21 for purchase and removal of three 25 m.g.d. vertical turbine motor driven electric pumps, direct connected to a.c. motors, 25 cycle, 2,200 v; three 1,000 kw. air cooled transformers, 1,000 to 2,000 v.

Pumps and Compressor, etc. — City of Amarillo, Tex., air lift pumps and compressor, etc., for proposed waterworks. Estimated cost $100,000.

Refrigerating Unit—Bureau of Yards & Docks, Navy Dept., Washington, D. C., automatic refrigerating unit for Navy Yard Hospital, Philadelphia, Pa.

Industrial Projects

Ala., Birmingham—PIPE and FITTING FACTORY—Stockham Pipe & Fitting Co., 4600 10th Ave., awarded contract for the construction of a 2 story 104 x 251 ft. warehouse and shipping building and 1 story, 60 x 95 ft. laboratory to H. K. Ferguson Co., Hanna Bldg., Cleveland, O. Estimated cost $150,000.

Calif., Los Angeles—CAN FACTORY—Continental Can Co., 303 San Fernando Rd., is having plans prepared for a 2 story, 300 x 600 ft. factory at Union Pacific Tract. Francisco & Jacobus, Pershing Sq. Bldg., are architects.

Conn., Bridgeport—TUBE and STAMPING FACTORY—American Tube & Stamping Co., 766 Stratford Ave., awarded contract for a 3 story, 35 x 100 ft. factory, to T. J. Pardy Construction Co., 1481 Seaview Ave. Estimated cost $50,000.

Conn., New Haven — COKE PLANT — Koppers Co., Waterfront St., awarded contract for the construction of a 2 story coke screening plant, 4 story brick oven bin and two chimneys, 20 ft. in diameter, 250 ft. high, to Koppers Construction, Alabama Ave. Estimated cost $155,000.

Ill., Mount Vernon — FACTORY and BOILER ROOM—J. P. Devine Manufacturing Co., 1372 Clinton St., Buffalo, N. Y., manufacturers of chemical apparatus, vacuum dryers, evaporators, impregnators, etc., will build a factory including boiler room, etc., here. Estimated cost $600,000. Private plans. Work will be done by owner's forces.

Ind., Fort Wayne—TRACTOR FACTORY—John Deere Co., Moline, Ill., is receiving bids for the construction of a 4 story, 100 x 100 ft. factory at Jackson and West Main Sts. Estimated cost $150,000.

Md., Baltimore—PAPERBOARD PLANT ADDITION—Chesapeake Paperboard Co., awarded contract for a 2 story, 80 x 180 ft. addition to paperboard plant to Fred Wright Co., 217 North Calvert St.

Mich., Detroit — AUTOMOBILE BODY FACTORY — Fisher Body Corp., General Motors Bldg., will soon award contract for a 1 and 3 story, 100 x 650 ft. automobile body factory on Beaubien St. H. E. Beyster, c/o owner, is architect. Owner is in the market for steam heating, electric motors and general equipment for handling automobile bodies in finishing department.

Mich., Jackson—MOTOR SHAFT FACTORY—Jackson Motor Shaft Co., Tyson St., and M. C. R.R., awarded contract for 1 story, 50 x 270 ft. factory for the manufacture of automobile shafts to J. F. Braun, 414 South Gorham St. Estimated cost $45,000. Steam heating, electric motors and miscellaneous machine shop equipment will be installed.

O., Euclid (br. Cleveland)—BRASS AND COPPER PLANT AND POWER HOUSE—Chase Brass & Copper Co., C. E. Hart, Jr., Secy., Waterbury, Conn., awarded contract for a 1 story, 225 x 1,000 ft. mill and 200 x 200 ft. power house to Austin Co., 16112 Euclid Ave., Cleveland. Estimated cost $1,250,000.

Wis., West Allis — FOUNDRY and HEATING PLANT — Allis-Chalmers Co. awarded contract for the construction of a 1 story, 100 x 200 ft. foundry, 1 story, 200 x 600 ft. tractor building and 100 x 150 ft. heating plant, to W. W. Oeflein Inc., 110 East Wisconsin Ave., Milwaukee.

Ont., Hamilton—STEEL PLANT—Steel Co. of Canada, Ltd., Harvey Lane, will build 1 and 2 story additions to steel plant. Estimated total cost $7,000,000. Private plans. Work will be done by day labor.

Ont., Windsor — AUTOMOBILE FACTORY AND POWER HOUSE — Chrysler Corp. of Canada, J. D. Mansfield, Mgr., awarded contract for the construction of first unit of 5 story, 280 x 1,000 ft. factory, including loading dock and storage building, power house, etc., on Tecumseh Rd. to Walbridge Aldinger Co., 2312 Penobscot Bldg., Detroit, Mich. Estimated total cost $1,500,000.